RYCOM INSTRUMENTS INC.
9351 East 59th Street
Raytown, Missouri 64133

INSTRUCTION MANUAL
6021A
SELECTIVE LEVELMETER

Serial No. _____

Manual Part No. 030 00027 00

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MODEL 6021A
SELECTIVE LEVEL METER

WARRANTY

This instrument is under warranty for one year from date of delivery against defects in material and workmanship (EXCEPTION — BATTERY). We will repair or replace products that prove to be defective during the warranty period.

This warranty is void if, after having received the instrument in good condition, it is subjected to abuse, unauthorized alteration or casual repair.

NO OTHER WARRANTY IS EXPRESS OR IMPLIED. THE WARRANTY DESCRIBED IN THIS PARAGRAPH SHALL BE **IN LIEU OF** ANY OTHER WARRANTY, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF **MERCHANTABILITY** OR FITNESS FOR A PARTICULAR PURPOSE. WE ARE NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

FACTORY SERVICE

The Rycom Model 6021A was designed for dependable operation with recommended annual inspection for correct operation. If, however, your 6021A is not working properly, return it to the factory for repair. We recommend that the unit be returned in the original containers in which it was received. Send the instrument PREPAID to:

Rycom Instruments, Inc.
9351 E. 59th Street
Raytown, Missouri 64133 U.S.A.
Telephone: 816-353-2100 or 800-851-7347
FAX: 816-353-5050

Normally, we will repair and ship back any instrument sent in within 10 working days, unless the instrument is unrepairable. In this case, we will advise you.

If you need information, call the Rycom Factory Repair Department at 816-353-2100. If you return your 6021A for service or repair, return authorization is not required. Please include the following information:

1. Name and telephone number of owner.
2. Brief description of symptoms or trouble.
3. Billing address and shipping address.
4. Purchase order number, if required.

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CHAPTER 1
GENERAL

1. SCOPE

This manual describes the Model 6021A Selective Levelmeter.

2. DESCRIPTION

The instrument is intended for general use where it is desired to measure the level of individual or narrow bands of frequency. It can be operated from its internal battery, or from 115 volts ac, 50-60 Hz, which is also used to charge the battery.

Table 1 lists the specifications and figure 1 shows the instrument.

The instrument is fully solid state. It will measure signal levels from -80 dBm to +42 dBm for a 600 ohm or 135 ohm reference and signal levels from -70 dBm to +52 dBm for a 50 ohm or 75 ohm reference. It will measure voltages from 77.5 microvolts to 100 volts. The narrow band filter, 50 Hz, 100 Hz or 250 Hz, in the MEASURE position makes it particularly useful for analyzing closely spaced signals, complex waveforms, determining carrier system levels and checking amplitude modulation percentages. A wide band filter, 2.5 kHz or 3.1 kHz, in the MONITOR position can be used for searching and monitoring. Special features include a calibration oscillator, a digital frequency display, a speaker, a headphone jack for aural monitoring and a built-in battery charger.

A compact metal cabinet 8 inches high, 12 inches wide and 9 inches deep, houses the instrument. Weight, including the battery, is 18.5 pounds. The front panel contains all the operating controls and is protected by a metal cover that snaps in place. The POWER switch must be set to the OFF position before the cover can be installed, thereby preventing the possibility of battery discharge while the instrument is not in use.

Circuitry is mounted on printed circuit boards and assembled into separate modules. Extensive shielding is provided for modules and components to prevent interaction between circuits.

The instrument will operate from the internal battery power or from 115 volts ac when the POWER switch is set in the ON position. The battery can power the instrument for more than 8 hours and will be charged while the instrument operates on 115 volts ac. A CHARGE position on the POWER switch is provided for overnight battery charging from ac power.

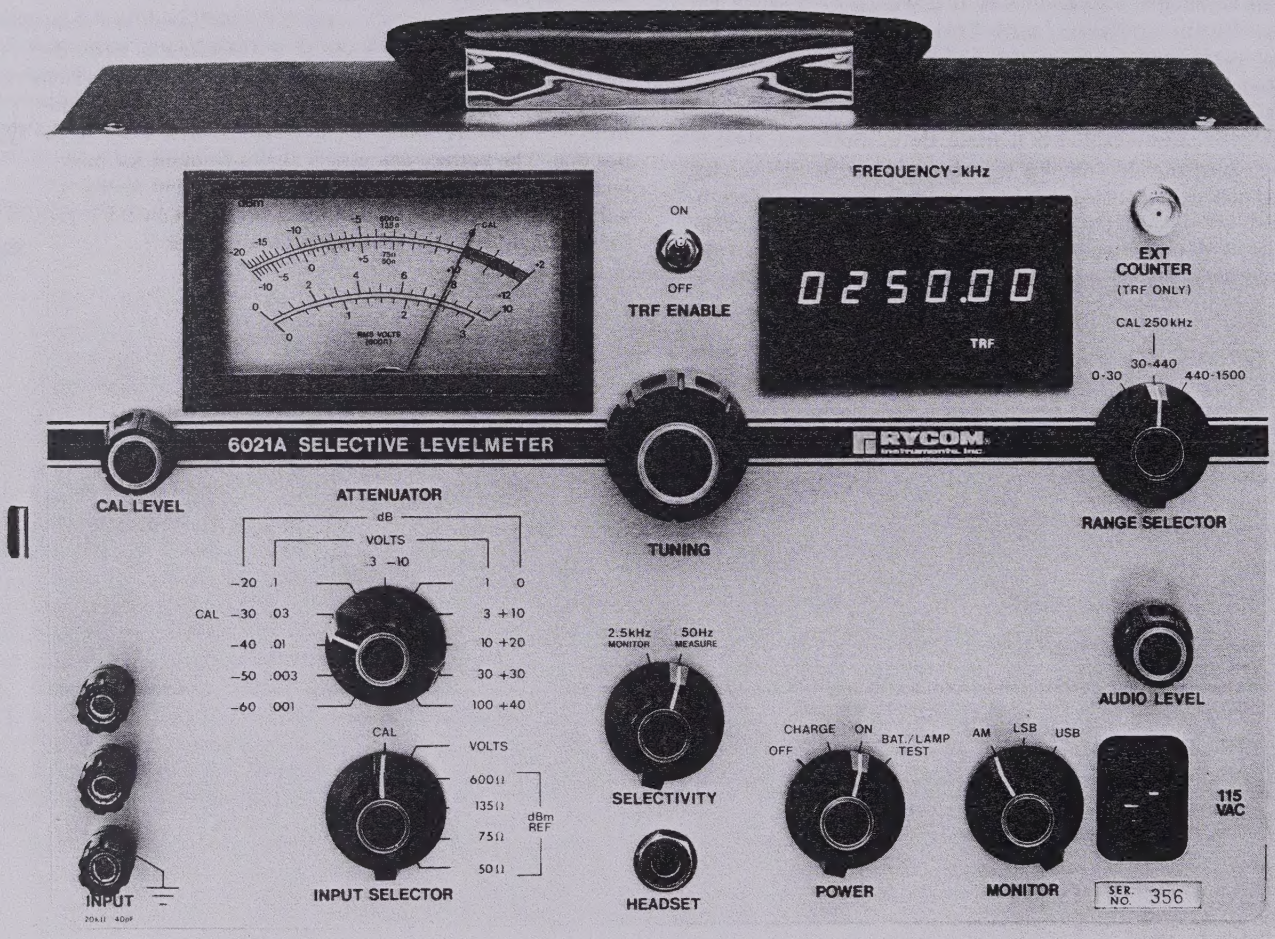

Figure 1. 6021A Selective Levelmeter

Table 1. Specifications

CHARACTERISTIC	SPECIFICATION
FREQUENCY:	
Range	200 Hz to 1500 kHz with 50 Hz selectivity 400 Hz to 1500 kHz with 100 Hz selectivity 3 Bands
Accuracy; TRF	±0.7 Hz or ±20 ppm whichever is greater at 25°C
Temperature Stability	Less than 2 ppm/°C drift
Resolution	Band A — 1 Hz Band B — 10 Hz Band C — 10 Hz
Display	6 digit LED in kHz units
Modes	TRF (True Restored Frequency) BFO with automatic mode switching for meter readings above -10 dB
LEVEL MEASUREMENT:	
Range	-80 dBm to +42 dBm (135 ohms, 600 ohms Ref. level) -70 dBm to +52 dBm (50 ohms, 75 ohms Ref. level) 77.5 μV to 100 volts
dBm Reference	Selectable, 50 ohms, 75 ohms, 135 ohms, 600 ohms
Attenuator Range	-60 dB to +40 dB
Accuracy	±1 dB: 1 kHz to 1.5 MHz for Attenuator set at +20 dBm or below. ±1 dB: 1 kHz to 500 kHz above +20 dBm
SELECTIVITY:	
Monitor	Standard: 2,500 Hz nominal between -3 dB points 10,000 Hz maximum between -60 dB points Optional: 3,100 Hz nominal between -3 dB points 12,500 Hz maximum between -60 dB points
Measure	Standard: 50 Hz nominal between -3 dB points 250 Hz maximum between -60 dB points Optional: 100 Hz nominal between -3 dB points 400 Hz maximum between -60 dB points
INPUT:	
Impedance	Unbalanced, bridging (20k ohm shunted by 20 pF) Balanced, bridging (40k ohm shunted by 20 pF, 20k shunted by 20 pF — each terminal to ground)
Configuration	Selectable, balanced or unbalanced (with grounding strap)
Connectors	Binding Posts
SPURIOUS RESPONSE AND INTERMODULATION PRODUCTS:	Better than -55 dB below a 0 dBm input Ref. level with 50 dB increase in sensitivity over the range 5 kHz to 1.5 MHz
INTERMEDIATE FREQUENCY:	2,215 kHz
IMAGE REJECTION:	Greater than 60 dB at 100 kHz
I-F REJECTION:	Greater than 70 dB
INTERNAL CALIBRATION SOURCE:	
Frequency	250 kHz nominal
Level Accuracy	Better than ±0.3 dB over operating temperature range
TYPES OF DEMODULATION:	AM, USB, LSB
FREQUENCY COUNTER OUTPUT:	50 millivolts minimum into 50 ohm load (BNC female connector)
AUDIO OUTPUT:	
Loudspeaker (Internal)	Greater than 100 milliwatts
Headphone (External)	50 milliwatts into phone jack terminated by 600 ohm load

Table 1. Specifications (cont.)

CHARACTERISTIC	SPECIFICATION
POWER SUPPLY:	One internal rechargeable battery or 115 volts, (230 volts optional) 50-60 Hz for AC operation or charging battery
Battery Capacity	8 hour normal operation. A discharged battery will recharge overnight
AC Watts	15 watts with fully charged battery, 26 watts with unit operating and battery discharged
TEMPERATURE RANGE:	
Operating	-10°C to +55°C
Storage	-40°C to +85°C
MECHANICAL:	
Dimensions	8″ x 12″ x 9″ (203.2mm x 304.8mm x 228.6mm)
Weight	18.5 lbs. (8.3 kg.)

CHAPTER II
OPERATION

1. PREPARATION

The instrument has been thoroughly inspected at the factory and is covered by Warranty. However, before using the instrument, you should inspect it for shipping damage. Report any damage to the carrier and to RYCOM Instruments, Inc.

2. OPERATING CONTROLS AND INDICATORS

Table 2 lists and describes the instrument controls and indicators.

Table 2. Operating Controls and Indicators

PANEL MARKING	DESCRIPTION	FUNCTION
RANGE SELECTOR	3-position rotary switch.	Selects frequency ranges in three steps.
TUNING	Drives tuning mechanism.	Tunes instrument to frequency indicated on frequency display.
TRF ENABLE	2-position toggle switch.	ON position: Allows Frequency -kHz to display the incoming signal frequency provided the level is above -10 dBm. OFF position: Disables the TRF function. Frequency -kHz displays center frequency of the levelmeter.
SELECTIVITY	2-position rotary switch.	Selects bandwidth (measure) or (monitor).
ATTENUATOR	11-position rotary switch.	Controls sensitivity in 10 dB steps (-60 dB to +40 dB).
CAL LEVEL	Potentiometer.	Adjusts overall gain during calibration.
MONITOR	3-position rotary switch.	Selects AM or single sideband (LSB, USB) demodulation.
AUDIO LEVEL	Potentiometer.	Adjusts audio level for headset or speaker.
HEADSET	Headphone jack.	Provision for audio monitoring.
POWER	4-position rotary switch spring loaded in BAT./LAMP TEST position.	Controls ac line or battery power and provides for battery and display testing.
115 VAC	Polarized connector.	Provision for connecting to 115 volt ac line.
INPUT	Binding Posts.	Signal input for measurements.
INPUT SELECTOR	6-position rotary switch.	1. Selects dBm reference of 600 ohms, 135 ohms, 75 ohms, or 50 ohms, or volts. 2. Selects CAL position for calibration.
FREQUENCY-kHz	6-digit display with two indicator lamps.	Provides a display of frequency in kHz with 10 cycle resolution, or 1 cycle resolution for 0-30 Hz range. B[illegible] indicates the frequency displayed is the center frequency of the passband to which the meter is tuned. TRF lamp indicates the frequency displayed is the frequency of the input signal being measured.
No Marking	Meter.	Indicates with ATTENUATOR, the level of the detected input signal in dBm referenced to the impedance selected by the INPUT SELECTOR. Indicates VRMS of the detected input signal on one of two voltage scales when INPUT SELECTOR is in a 600 ohm position. Correct voltage scale and multiplier are determined by the ATTENUATOR setting.
EXT. COUNTER	BNC Connector.	Provides an output signal having an average frequency equal to the selected input signal any time a TRF frequency display is presented.

3. BATTERY

The battery will provide up to 8.5 hours of operating between charges. A completely discharged battery will recharge in 16 hours or less. The instrument cannot be operated when the POWER switch is in the CHARGE position as the charging circuit is switched into a quick charge state while the remainder of the circuitry is switched out. When the POWER switch is in the ON position and the AC power applied, the battery is charged, but at a rate slower than the quick charge rate.

If the instrument is operated on AC power more than 70% of the time, there should be no need for quick charging. If the instrument has operated battery powered for 8 hours, 20 hours of AC operation, or a quick charge should take place before a second 8 hours of battery operation.

NOTE: Excessive use of the quick charge should be avoided as excessive over-charging will shorten battery life.

a. To quick charge battery, connect instrument to primary source (115 V ac) and set POWER switch to CHARGE.

b. To test condition of battery while it is delivering full load current, set POWER switch to BAT./LAMP TEST. The meter indication for a charged battery will be greater than +1 dB. A meter indication at or below 0 dB indicates charging is required before battery operation.

CALIBRATION

a. Disconnect any input signal and set the instrument switches and controls as follows:

Switch/Control	Position
POWER	ON
INPUT SELECTOR	CAL
ATTENUATOR	CAL -30 dB
SELECTIVITY	MEASURE
TRF ENABLE	OFF
RANGE SELECTOR	30-440 kHz
TUNING	Peak meter reading near 250.00 kHz

NOTE: The calibration oscillator provides a signal for level calibration only. The oscillator frequency is nominally 250 kHz, but can be expected to deviate.

b. Adjust CAL LEVEL for a 0 dBm (600 ohm scale) reading. Unit is now calibrated to 0 dBm referenced to the selected input impedance, or for voltage readings, with the INPUT SELECTOR in the VOLTS position.

5. INPUT SELECTOR SETTING

a. **INPUT SELECTOR on VOLTS.** Use this position to connect across any line to make voltage measurements. Calibrate according to paragraph 4.

b. **INPUT SELECTOR on 600 Ohms.** Use this position for a 600-ohm line to make dBm (1 mW in 600 ohms) measurements. Calibrate according to paragraph 4.

c. **INPUT SELECTOR on 135 Ohms.** Use this position for a 135-ohm line to make dBm (1 mW in 135 ohms) measurements. Calibrate according to paragraph 4.

d. **INPUT SELECTOR on 75 Ohms.** Use this position for a 75-ohm line to make dBm (1 mW in 75 ohms) measurements. Calibrate according to paragraph 4.

e. **INPUT SELECTOR on 50 Ohms.** Use this position for a 50-ohm line to make dBm (1 mW in 50 ohms) measurements. Calibrate according to paragraph 4.

6. LINE MEASUREMENTS

a. To make measurements below 500 Hz, perform the following:

(1) Remove the ac line cord from the 115 VAC receptacle to avoid possible spurious responses at 60 Hz harmonics.

(2) Set POWER switch to ON position and calibrate the instrument according to paragraph 4.

(3) Set INPUT SELECTOR switch to desired impedance and termination. See paragraph 5.

(4) Disconnect the E2,E3 jumper if the signal input is balanced.

(5) Set the ATTENUATOR at or above 0 dB if the circuit to be tested has signals at a level greater than +20 dBm.

(6) Connect the instrument INPUT terminals (RED) to the circuit to be tested.

(7) Set RANGE SELECTOR switch and adjust TUNING control to frequency of signal to be measured.

(8) Set ATTENUATOR switch so meter indicates in upper 2/3 of scale.

(9) Adjust TUNING control for maximum indication on meter.

(10) Read meter indication in dBm. To obtain the input signal level, algebraically add meter indication to ATTENUATOR switch setting.

b. To make measurements above 500 Hz, perform steps (2) thru (10).

7. MONITORING

Provision is made for monitoring audio signals that may be present on line signals under measurement. To monitor signals, set SELECTIVITY switch to MONITOR, set MONITOR switch to desired position (AM, LSB, or USB), and adjust AUDIO LEVEL control to the desired audio level.

8. FREQUENCY DISPLAY

TRF frequency readings are a measure of the frequency of the input signal in the instrument pass band. BFO frequency readings indicate the frequency to which the instrument is tuned. This instrument will automatically switch to the TRF mode when the input level reading exceeds –10 dB and the TRF ENABLE switch is in the ON position. If a pulsed or modulated input signal causes excessive mode changing or averaged frequency displays, TRF readings can be inhibited by putting the TRF ENABLE switch in the OFF position.

NOTE: Switch to a BFO mode (TRF ENABLE switch OFF) when level reading accuracy must be maintained. The active EXT. COUNTER output has a frequency equal to that of the selected input. External and internal feedback from this output port to the instrument may generate level reading errors.

CHAPTER III
THEORY OF OPERATION

1. GENERAL

The instrument employs a single conversion super-heterodyne circuit with a selectable bandpass to measure frequencies in the range of 200 Hz to 1500 kHz. Figure 14 is a functional block diagram of the instrument and figure 16 is the basic schematic diagram.

At the input of the instrument, a switch is used to select the input signal from the calibration oscillator or from the front panel INPUT jacks. A low-pass filter and matching network are incorporated into the input circuit to attenuate unwanted high-frequency components and to provide proper impedances.

A variable attenuator provides up to 100 dB of attenuation in 10 dB steps to control sensitivity of the instrument. Tuning of the instrument is accomplished by a variable local oscillator whose output varies from 2,215 to 3,715 kHz. The input and local oscillator signals are heterodyned in a mixer to produce a 2,215 kHz difference frequency. The I-F amplifier is tuned to 2,215 kHz and it amplifies the mixer output.

The selectivity of the instrument is determined by crystal filters between the first and second I-F amplifiers. After amplification by the I-F amplifier, the signal is rectified and filtered in a meter detector circuit and then applied to a meter.

The second detector, when used with an insertion frequency of 2,213.5 kHz and 2,216.5 kHz will produce single sideband demodulation for audio monitoring.

The calibration oscillator generates a signal and is amplitude regulated to provide an output level that is equivalent to –30 dBm at the INPUT jacks. Before measurements are made, the instrument sensitivity is calibrated by connecting the calibration oscillator output to the instrument input circuits and adjusting the I-F amplifier gain for a meter indication of 0 dBm with a –30 dBm attenuator setting.

When the instrument is used for power measurements, the variable attenuator is used to change sensitivity in calibrated steps of 10 dB. For example, assume that a signal level of –42 dBm is applied to the instrument input. Adjusting the attenuator to the –40 dB position will result in a meter indication of –2 dBm. The input level is then determined by algebraically adding the meter indication to the attenuator setting:

$$-40 \text{ dB} + (-2 \text{ dBm}) = -42 \text{ dBm}$$

The local oscillator and I-F signals are mixed to produce a count signal to generate a TRF frequency display. For a BFO frequency display, the local oscillator and counter reference oscillator signals are mixed to produce the count signal.

2. INPUT ASSEMBLY

The input circuits are composed of INPUT SELECTOR switch S2, S1 and a 100-dB ATTENUATOR assembly AT1. The input impedance for each terminal to ground is greater than 20k shunted by 20 pF.

Associated with each input terminal is an L-Pad. For E1 the series leg of the L-pad consist of R1 and C1. For E2 the series leg consist of R2 and C2. The position of the INPUT SELECTOR S2 determines the shunt leg of the L-pad. By adding resistors in parallel with the branches consisting of L6, R4, L7 and R5, the attenuation of the L-pads is switched to accommodate the dBm reference selected by the position of S2. With S2 in a CAL position the two input terminals are disconnected and a CAL oscillator signal replaces the E1 signal. Inductors L4 and L7 provide frequency compensation for the distributed capacitance of the input circuitry and attenuator AT1.

3. CALIBRATE OSCILLATOR ASSEMBLY A11

The calibrate oscillator is 250 kHz, crystal-controlled. The output level is controlled by voltage regulator A11I2. The output is applied through CAL OSC ADJ potentiometer A11R5 to switch S2 for calibrating the instrument level readings.

4. ATTENUATOR AT1

Following the INPUT SELECTOR is the dual attenuator AT1. Two identical attenuators consist of switch AT1S1 and resistors making up the L-pads which are selected and combined to provide equal attenuation for the E1 and E2 input signals. Located in the center of AT1S1 between the attenuators is the SUMMING AMPLIFIER A2 which combines the attenuator signals to provide an output signal which represents the attenuated difference between the two input signals. Summing amplifier inputs are high impedance to prevent attenuator loading. The output impedance is matched to the lowpass filter impedance. Source followers A2Q1 and A2 Q2 provide the high input impedance. The followers drive two complimentary transistors A2Q3 and A2Q5 which share a common emitter resistor A2R11. The voltage across A2R11 is the difference between the amplifier input signals and determines the collector current of A2Q5 which, in turn drives the output. Trim pot A2R3 provides an adjustment of the gain of A2Q1 follower and optimizes common mode rejection.

5. LOWPASS FILTER FL3

The lowpass filter has a cutoff frequency of 1,760 kHz and provides 70 dB of attenuation at 2,215 kHz. Input and output impedances are 150 ohms.

6. OSCILLATOR-MODULATOR ASSEMBLY A3

The input signal is heterodyned with the local oscillator injection signal in balanced modulator diodes A3CR1. The diodes operate as a balanced shunt modulator, shorting the signal to ground during one-half the local oscillator cycle. Potentiometer A3R2 provides for mixer balancing to reduce the local oscillator component fed to the I-F Assembly. The 2,215-kHz output of the modulator is capacitively coupled to the base of first I-F amplifier A4Q1.

The modulator driver A3Q1 output is transformer-coupled through A3T1 to the modulator diodes. Input to the modulator driver is capacitively coupled from the emitter of local oscillator A3Q2.

The local oscillator is a modified Colpitts type with three switched frequency ranges. The frequency in each range is varied by adjusting TUNING capacitor C4, an 11-150 picofarad air-dielectric capacitor.

Emitter follower stage Q1 mounted on the local oscillator chassis provides a buffer between the oscillator and frequency display A6.

7. I-F ASSEMBLY A4

The 2,215-kHz output of the modulator is capacitively coupled to the First I-F amplifier A4Q1. The amplifier and filter driver consists of three stages: A4Q1, A4Q2 and A4Q3. Gain is controlled by A4R5. Output of A4Q2 is transformer coupled to A4Q3, the filter driver.

The instrument has two crystal filters which are selected by the SELECTIVITY switch A4S1. The center frequency of both filters A4FL1 and A4FL2 is nominally 2,215 kHz.

Trimmer capacitors A4C7 through A4C10 tune the filters for maximum flatness. Each filter has an input impedance of 4,000 ohms and an output impedance of 1,000 ohms.

The filter matching amplifier and second I-F amplifier consists of three stages: A4Q4, A4Q5 and A4Q6. Output of the crystal filter is capacitively coupled to filter matching amplifier A4Q4-A4Q5. CAL LEVEL control R11 is used to adjust bias current for A4Q5, thus controlling gain of the stage. The output of A4Q5 drives common-emitter amplifier A4Q6. The second I-F amplifier has a gain of 20 to 40 dB, depending upon the setting of CAL LEVEL control R11.

Third I-F amplifier A4Q7 provides 30 dB of gain and is transformer-coupled to I-F output amplifier A4Q8. The output of A4Q7 is also capacitively coupled to the meter detector circuit.

Meter detector diode A4CR1 is a half-wave detector with its output applied through A4R27 to power switch S3 which is connected to the meter and a level detector in the frequency display A6.

I-F output amplifier A4Q8 acts as a buffer driving the reinsertion mixer and the frequency display.

8. MONITOR ASSEMBLY A5

The AM demodulator is a shunt type. A5CR2 is the diode. MONITOR switch A5S1, when in the AM position, connects the cathode of A5CR2 to ground. R-F filtering is done by A5C8 and A5R12. The audio signal is capacitively coupled from AUDIO LEVEL control R12 to the input of audio amplifier A5I2.

The sideband demodulator consists of A5CR1 and A5CR2, which is supplied with carrier signal from A5Q2. These diodes operate as a balanced shunt demodulator that shorts the I-F signal to ground during one-half the injection signal cycle. This produces an audio difference signal that is coupled to the audio amplifier A5I2. The difference signal is approximately 1.5 kHz.

Carrier reinsertion oscillator A5Q1 is crystal-controlled by A5Y1 or A5Y2. The output is coupled to balanced phase splitter A5Q2, which supplies out-of-phase signals to demodulator diodes A5CR1 and A5CR2. MONITOR switch A5S1 is used to apply power to A5Q1 and A5Q2 and select the crystal for LSB or USB demodulation. LSB crystal A5Y2 is 1.5 kHz below and USB crystal A5Y1 is 1.5 kHz above the I-F center frequency of 2,215 kHz.

9. AUDIO AMPLIFIER ASSEMBLY A5

The audio amplifier is composed of A5I2a and A5I2b an integrated circuit. The output of the demodulator is fed through R-F decoupling network A5R12 and A5C8 to AUDIO LEVEL control R12. Signal at the arm of R12 drives the bridge audio amplifier A5I2. Voltage gain of the audio amplifier is approximately 50 dB providing 200 mW output to the 100 ohm speaker LS1.

10. REGULATOR ASSEMBLY A5

The regulator consists of a 5 volt, three terminal regulator A5I1 and a 4.3 volt reference diode. The regulator output voltage will nominally be 9.3 volts.

11. DIGITAL FREQUENCY DISPLAY ASSEMBLY A6

The digital frequency display assembly consists of three circuit card assemblies, the Display Readout Assembly A7, the Timing and Mixer Assembly A8 and Counter Output Assembly A10. Figure 15 is the Block Diagram and Figures 16,17,18 and 19 are the Schematic Diagrams of the display circuitry.

The timing signals generated by A8 controls the A7 counter such that the count signal to A7 is counted for 0.2 seconds. After a count has been accumulated, it is stored in the latches and displayed while a new count is accumulated. The count signal is generated by mixing the local oscillator input signal with either the I-F signal for a TRF readout or the beat oscillator signal for a BFO readout. The count signal will be one-half the frequency difference of the local oscillator signal and the second signal for the 30-440 and the 440-1500 kHz ranges. The count signal will be one-half the input frequency for the TRF mode. When this signal is counted for 0.2 seconds, the resulting count is one-tenth the input frequency to give a 10 cycle resolution readout. In the 0-30 kHz range, a count signal 5 times the frequency difference provides 1 cycle resolution.

The BFO frequency is offset 10 kHz below the I-F frequency to eliminate cross talk between the display and I-F circuits. This frequency offset in a BFO mode is subtracted from the count accumulated by delaying the start of the count interval to the higher order counter digits until after the offset counts have occurred.

The start of a count interval is synchronized with the count signal. This synchronization provides a count accuracy approaching ±0.5 cycles for lower frequency inputs.

Display Timing and Mixer Assembly A8: The functioning of display circuits will be described as they occur in the various blocks of Figure 15. The following discussion assumes the reader has a knowledge of COS/MOS I-C's. Appendix "A" describes the operation of the various COS/MOS I-C's used in the display.

Reference Oscillator: The reference oscillator performs two functions. It produces a crystal controlled 2,205 kHz clock signal used to generate an accurate 0.2 second count interval. The same clock signal, after a division by 2 by A8I4b acts as a beat oscillator signal to be mixed with the local oscillator signal for a BFO frequency display. A8I25 and A8Q2 form a crystal controlled oscillator having a logic level output. The Q output of the clock divider A8I4b is controlled by the BFO/TRF control block. The Q output will be lo for a TRF mode and a 1,102.5 kHz signal for a BFO mode.

Counter Timing: The counter timing signal generator consists of a counter comprised of A8I8, A8I9 and A8I10, count decoding logic comprised of flip-flops A8I14a and A8I14b and gates A8I12a, A8I13c, A8I13d, A8I12b, A8I13b, A8I12c and A8I13a.

Counter A8I8 and A8I9 are modulus ten counters connected to form a modulus 100 counter. Each cycle of the 100 count counter A8I10, a binary counter is advanced. On Count 4410 of A8I10, flip-flop A8I14b is set. At the start of each 100 cycle count, the state of A8I14b is sampled by flip-flop A8I14a. When flip-flop A8I14a is set, it remains set for a 0.2 second interval (441,000 counts). During the 0.2 second count interval, gate A8I13a is enabled and a count signal is provided to the Counter Display board A7.

A8I14a is reset on count "0" of A8I9 at the end of a count interval. On the cycle of counts from A8I9 following the resetting A8I14a, signals are generated for conditioning A7 for the next count interval. Provided a lo input to A8I12c from A8I6a of the BFO/TRF block does not indicate an invalid count, a lo going latch enable pulse will be generated on count 5 of A8I9. This latching stores the just completed count for displaying during the next count interval. If a hi from A8I18b of the low frequency detector is indicating a too low count, a hi going master reset pulse from A8I13d will reset the A7 counters and an all "0" count will be latched and displayed. On count 7 of A8I9, the normal master reset pulse will occur following the latching. The master reset pulse initializes A7 for the next count. A8I10, A8I6a, A8I19a, A8I19b and A8I20 are also reset or preset by the master reset pulse.

Flip-flop A8I11b is set on count 8. This permits resetting of A8I8 by a hi output from A8I7c on count 9. With the hi A8I7c output, A8I8 is inhibited from counting and set to a "0" count state. When the count signal from A8I11a falls, A8I11b will be reset and a new count interval will be started. This action synchronizes the start of a count interval to within 0.5 micro seconds of the start of a count signal cycle. A7 counters advance on the fall of the count signal which occurs near the center of a count signal cycle. The count accuracy will approach ±0.5 cycles at lower frequencies and last digit jitter will be reduced to a minimum.

Local Oscillator Buffer: Differential amplifier A8I1 and transistor A8Q3 amplify the local oscillator input signal to logic

levels and provide buffering between the local oscillator and logic. Flip-flop A8I5b divides the local oscillator frequency by two. Both mixer blocks require half the local oscillator frequency.

I-F Buffer: A8I2 is a medium speed comparator used to convert the I-F input signal to logic levels. Flip-flop A8I5a divides the I-F frequency by two when the unit is in a TRF mode. When the unit is in a BFO mode, the D.C. reset input will be a static hi and the Q output will follow the D.C. set input derived from the reference oscillator block.

BFO/TRF Control: A8I3a is one half of a dual op-amp used as a comparator. A8R17 is set such that with a meter level reading over -10 dBm, the meter D.C. input will drive the A8I3a output lo. If the TRF ENABLE switch S4 is on, A8E5 and A8E11 will be connected and flip-flop A8I6b will be clocked to a TRF state with the rise of the Disable #1 pulse. If the D.C. meter signal drops below the switch-over point bringing A8E5 hi or if the TRF ENABLE switch is turned off, a hi signal at A8E11 will put A8I6b to a BFO state. Any change of A8I6b to a BFO state will clock A8I6a to an inhibit latch state. The inhibit latch state will be removed by the first master reset pulse to follow. This prevents non-zero counts derived during a count interval in which the mode changed to BFO, from being displayed. Transistors A8Q5 and A8Q6 are emitter followers used to light BFO and TRF indicator lamps.

High Range Mixer: The high range mixer is employed for the 30-440 and 440-1,500 kHz ranges. It is a D type flip-flop A8I11a. When a D flip-flop has a square wave D input and a clock input at a higher frequency than the D input, but less than twice that frequency, the output will change state at a rate equal to the difference frequency between the two inputs. For a TRF mode, the mixer output (count signal) will be one-half the input frequency. Counting for 0.2 seconds will give a count equal to one-tenth the input frequency. The BFO mode output generates 1,000 extra offset counts which will be subtracted by the BFO subtraction block. In the 0-30 kHz range, the DC set input will be hi and $\overline{Q}$ of A8I11a will follow the DC reset input from A8I16a of the X5 block.

Low Range Mixer: At low difference frequencies, a D flip-flop type mixer is susceptible to generating error pulses resulting from jitter in either of the two input signals. Gates A8I7b, A8I15a, A8I15c, flip-flop A8I16b and A8I17b along with buffer flip-flop A8I5a and A8I5b form a mixer not susceptible to jitter.

Gate A8I15a will have a hi output for one-half cycle of the local oscillator signal on alternating cycles. This gate output will be sampled at A8I16b by the Q output of A8I5a which is one-half the frequency of either the I-F or BFO signal. When the hi gate signal from A8I15a is sampled, flip-flop A8I16b will be set and will in turn, change the state of flip-flop A8I17b. A8I17b controls the phase of the A8I15a gate output. Each time A8I17b changes state, the gate output will shift 180°. Before another hi gate output can be sampled, a 180° phase shift between the A8I16b inputs must occur. A8I16b will remain in the set state for a single cycle of the A8I5a Q output. These hi state pulses from A8I16b Q will occur at a rate equal to the difference frequency between the local oscillator and I-F or BFO signals.

X5 Multiplier: The multiplier consists of circuits A8I24, A8I3b, A8I23, gate A8I21b and flip-flops A8I22a, A8I22b, A8I18a and A8I16a. A8I24 is two multivibrators connected in cascade to form a voltage controlled oscillator (VCO). The frequency of oscillation is controlled by the voltage on the base of transistors A8Q7 and A8Q8 which supply charging current to the multivibrator timing capacitors. A8I23 is a decade counter used to count the VCO cycles. When the VCO frequency is too high, and ten VCO cycles are generated in less than a clock input interval to A8I18a, flip-flop A8I22b will provide negative pulse inputs to A8I13b, an inverting integrator. The A8I22b pulses will drive the A8I3b output upward reducing the VCO frequency. While the VCO frequency remains hi, low outputs from gate A8I21b will limit VCO output pulses to 10 per input cycle. When the VCO frequency is low and less than ten VCO cycles occur per input interval, the clocking of A8I18a will also generate a positive pulse input to the inverting integrator from A8I22a. The A8I22a pulses will drive the A8I3b output downward and will increase the VCO frequency. The input to A8I18a from the low range mixer will be equal to the input frequency in a TRF mode. The VCO will operate at 10 times that frequency. Flip-flop A8I16a divides the VCO frequency by 2 to provide one cycle resolution with the 0.2 second count interval.

Range Switch: DC control signals from the RANGE SELECTOR switch A3S1 determine if the A8I11a $\overline{Q}$ output is controlled by the D and clock inputs for the upper ranges or by the DC reset input for the 0-30 range. These signals also activate the low frequency detector in the 0-30 range and control the location of the decimal point and the magnitude of the BFO subtraction.

BFO Subtraction: Since the reference oscillator frequency used to generate a BFO display is 10 kHz below the I-F frequency, a 10 kHz correction is required in the display count. This correction is made by delaying the counting of the three higher order A7 display counter digits until the required number of count inputs have occurred. Counter Circuit A8I20 is used to count overflow pulses from the first set to the second set of three display digits to determine when the subtraction is complete. A8I20 is a presettable up/down counter used in the down count mode. The carry-out output from the circuit is used to drive the Disable #2 input to the A7 display assembly. The output will be lo and permit the most significant A7 digits to count when a zero count is reached. When the unit is in a TRF mode, a hi TRF signal provides a reset input to A8I20 and generates a lo Disable #2 signal. In a BFO mode, the Master Reset signal will preset the counter to a 10 for the 0-30 range and to a 1 for the other ranges. Gate A8I21c prevents additional counts once the zero count has been reached.

Low Frequency Detector: The frequency display will be set to zero whenever the count drops below about 190 or the local oscillator frequency is below the I-F frequency.

The dual decade counter A8I19 and gate A8I15b detect the magnitude of the count. The Master Reset signal sets the counters to zero. The Disable #2 input to the least significant decade delays any counting until after a BFO subtraction is completed. The count input is derived from the A8I23 of the multiplier. The A8I19 counter will be advanced once every 5 counts of the A7 display counters. On a count of 38, the A8I19a Q3 output of the second decade will go hi. Acting through gate A8I15b, this hi will inhibit any further counting of the second decade and will permit flip-flop A8I18b to be controlled by the D and clock input. The 38 counts will correspond to 190 display counts. For a range other than the low range, a hi input from the range switch will hold the A8I15b output lo.

Flip-flops A8I4a and A8I17a aid in detecting when the local oscillator frequency is less than the I-F frequency. When the local oscillator frequency is less than the I-F frequency, the clock input to A8I18b will sample a hi output from A8I17a Q. A Hi output from A8I18b Q provides a hi input to gate A8I12b which results in an early Master Reset pulse which generates an all 0 display. If the count is greater than 190 and the local oscillator frequency is greater than the I-F frequency, the removal of the DC set input to A8I18b will be followed by a clocked resetting and the A7 count will be displayed.

Test Control: The A8E18 input will normally be hi providing for a hi phase signal and a lo blank signal through inverter A8I21a to the A7 count decoders. When the POWER switch is placed in the BAT./LAMP TEST position, A8E18 will go lo. Since the resulting hi blank signal is also accompanied by a lo phase signal, an all 8's display is generated.

Display Readout Assembly A7: Clock signals from A8 are

counted by A7I1 and A7I6, two three-decade counters operating in cascade. In addition to counting stages, these two I-C's each contain Latches for storing the count presented to the BCD outputs and the gates required to multiplex the three decades to a single BCD output. The multiplexer is clocked by a 22.05 kHz signal from A8.

The BCD signals are decoded to seven segment signals by the two decoder drivers A7I2 and A7I7.

I-C's A7I3, A7I4, A7I5, A7I8, A7I9 and A7I10 are high intensity seven segment readouts. Readout cathodes are driven from the decoder drivers through current limiting resistors. Anode voltages are supplied by transistors A7Q1, A7Q2, or A7Q3 as driven by digit commands from the multiplexing portion of A7I1.

The reset input to A7 resets the counters and synchronizes the multiplexed outputs. The reset input occurs during the time counting has been disenabled and after a Latch Enable signal has transferred the 0.2 second count-interval count to storage.

When the lamp test input to the display at A8E18 goes low, a high blank signal with a low phase signal generates all 8 outputs from the decoders.

Transistors A7Q4 and A7Q5 control the location of the decimal point for the 1 Hz and 10 Hz resolutions. The collector of A7Q5 will be at 0 volts and the decimal point of A7I5 will be lit for the 0-30 range. The collector of A7Q4 will be at 0 volts and the decimal point of A7I4 will be lit for the other two ranges.

Counter Output Assembly A10: The A10 assembly is an auxiliary assembly providing an output at J5 that may be used to drive an external counter. When the unit is tuned to a signal in one of the two higher frequency bands with a TRF frequency display, the input to A10 from A8E21 will have a frequency 0.5 times the signal frequency.

A hi input from A8E22 indicates TRF operation and enables the input from A8E21 to propagate through A10I1a and A10I2a to exclusive OR gate A10I1d. Each time the A8E21 input changes state, the output of A10I1d will rise. After a propagation delay through A10I1c, the A10I1d rise will toggle flip-flop A10I2b. The toggling of A10I2b changes the state of the 2nd input to A10I1d and returns the output of A10I1d to a lo state. This means that each change of state of the A8E21 input will generate a positive pulse at the A10I1d output. The width of the pulses depend on propagation delays through A10I1c, A10I2b and A10I1d. The pulse rate will equal the frequency of the signal to which the unit is tuned.

When the unit is tuned to a signal in the low frequency band and a TRF frequency display is generated, the input from A8E20 will be at the input signal frequency. A hi input from A8E23, indicating low band operation, prevents A10I2b from toggling and the output of A10I1d remains at the input signal frequency. The input from A8E23 controls whether or not the count input from A8 is doubled. A lo input from A8E22 prevents an output whenever the unit display is not in a TRF mode.

Gate A10I1b provides a buffer between A10I1d and the J5 load. The resistor divider consisting of A10R2 and A10R3 prevents excessive output currents through J5. Excessive output current at the input signal frequency may generate feedback to input leads or within the 6021A that might cause excessive errors in signal level readings.

12. CHARGING CONTROL ASSEMBLY A9

The charging control board controls the voltage applied to the lead acid storage battery when the instrument is connected to an ac power source. Power from the dc power supply is applied between terminals A9E1 and A9E3. The positive voltage is applied to A9E1. A three terminal regulator A1I1 in the power supply holds the A9E1 voltage 5.0 volts above a reference voltage generated at A9E2. The constant 5.0 volt drop across A9R3 and A9R4 along with a constant current input to A9E2 from the power supply regulator provides for a constant current flow through A9RT1, A9CR1 and A9R5 in parallel and in series with A9R6. This constant current and the resulting A9E2 and A9E1 voltages are set by adjusting A9R3.

The ac power at A9E1 is coupled through A9CR2 and A9E4 to the power switch and on to the battery and the rest of the instrument when the POWER switch S3 is in the ON position. If no ac is applied, A9CR2 prevents battery power from being lost through the control and power supply. A9R3 is adjusted for the application of a 13.5 volt float voltage to the battery and instrument at 25° C.

Transistor A9Q1, resistors A9R1, A9R2, A9R9 and diode A9CR3 act to limit the current supplied. This action prevents excessive current flow through a very low battery. A9E4 and A9E5 are shorted, meaning transistor A9Q2 is held off when the power switch is in the ON position.

Temperature sensitive components thermistor A9RT1 and stabistor A9CR1 provide for a change in voltage at A9E2 with temperature and ensure an optimum float voltage over a wide temperature range.

With the POWER switch in the CHARGE position, transistor A9Q2 is permitted to turn on and the A9E4 voltage is applied only to the battery. The voltage at A9E4 will vary according to the state of charge on the battery. For a charged battery and low current flow through A9R2, A9Q1 will be off. The voltage at A9E4 will be about 13.6 volts. If the battery is charging at about 100 mA rate, A9Q1 will be partly turned on and will turn on A9Q2. With A9Q2 on and A9CR3 off, the current through A9Q2 increases the voltage drop through A9R6 and results in about 14.4 volts at A9E4. This provides for optimum charging of a low battery. Additional increases in charge current due to battery condition will eventually turn on diode A9CR3. Current flow through A9CR3 lowers the A9E4 voltage and keeps the charging current within a safe limit.

Three terminal regulator A9I1 provides 8.0 volts dc power to the LED readouts. This protects the 9.3 volt dc supply from the influence of pulsating LED current loads.

13. POWER SUPPLY ASSEMBLY A1

The power supply module consists of slide switch A1S1, power transformer A1T1, bridge rectifier A1CR1, filter capacitor A1C1, three terminal regulator A1I1 and filter capacitor A1C2. The dc voltage out of the regulator at terminal 2 is controlled by the bias voltage applied at terminal 3 supplied from A9E2 of the charging control board. A1I1 is a 5 volt regulator meaning the regulator output voltage will be 5 volts above the A9E2 voltage.

The battery is connected through R10 to POWER switch S3 for checking battery condition. A fully charged battery will provide a meter indication greater than +1 dB when the POWER switch is rotated to the BAT/LAMP TEST position. A meter indication of 0 dB or less means charging is required before battery operation.

Slide switch A1S1 provides for changing the primary winding configuration to either 115 V or 230 V AC power operation. In order to preserve the integrity of the case, the unit must be uncased to obtain access to the fuse or power voltage switch. The fuse and switch are both accessible from the bottom side of the uncased unit.

NOTE: A change from 115 V to 230 V operation additionally requires a change in the unit fuse. A 3AG 3/16 Amp slo-blow fuse is required for 115 V operation and 3AG 1/10 Amp slo-blow fuse is required for 230 V operation.

CHAPTER IV
MAINTENANCE

1. INTRODUCTION.

This instrument will give comparatively trouble-free performance provided normal operating procedures are observed. In the event of any malfunction, first check the battery by turning the POWER switch to the BAT./LAMP TEST position and observe the meter for an indication of greater than 0 dBm.

Before attempting to trouble-shoot the instrument, you should study Chapter III, Theory of Operation.

2. TEST EQUIPMENT.

The test equipment of table 3 is required to test and align the instrument.

Table 3. Test Equipment

NAME	USE	REQUIRED CHARACTERISTICS
Sweep Generator and Display Unit	Align I-F amplifiers and crystal filters	1. Center frequency between 50 and 500 kHz. 2. Sweep width variable from 5 to 40 kHz. 3. Sweep rate: 1/sec. to 4/sec.
Vtvm		Triplett 850 or equivalent.
Frequency Counter		1. Minimum counting rate 3,000 kHz. 2. Gate time 1 sec. and 0.1 sec. 3. Variable display time.
Signal Generator		Hewlett-Packard 651 or equivalent.
Ac vtvm		Hewlett-Packard 400E or equivalent.
Oscilloscope	Trouble shoot display.	Tektronics 465 or equivalent.

3. TROUBLE SHOOTING.

Before proceeding with step 1 in table 4, connect equipment in the test setup shown in figure 2 and perform the following steps:

a. Set the instrument switches and controls as follows:

Switch/Control	Position
INPUT SELECTOR	600Ω
RANGE SELECTOR	30-440 kHz
TUNING	250 kHz
ATTENUATOR	0 dB
CAL LEVEL	Fully Clockwise
SELECTIVITY	MONITOR
TRF ENABLE	OFF

b. Adjust signal generator for 0.78 V, 250-kHz output signal.

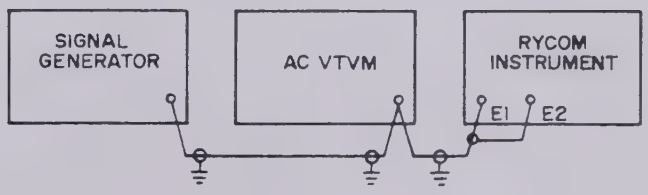

Figure 2.
Test Setup for Assembly Isolation

Table 4. Assembly Isolation

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Turn unit on. Rotate POWER switch to BAT./LAMP TEST.	Meter reads above 0 dB.	Battery needs recharge or Power system. See table 5.
2	Rotate POWER switch to BAT./LAMP TEST.	Display indicates 8888.88 BFO indication.	Trouble is in Assembly A6. See table 6.
3	Set TRF ENABLE switch to ON and rotate POWER switch to BAT./LAMP TEST.	TRF indication.	Trouble is in Assembly A6. See table 6.
4	Tune to 250 kHz. Adjust CAL LEVEL for 0 dB meter indication.	0 dBm meter reading. Display indicates 250.00 kHz. TRF indicator lamp on.	0 dB not attained. Go to step 6. Display or indication incorrect. Trouble is in Assembly A6. See table 6.
5	Set ATTENUATOR to +10 dB.	-10 dBm meter indication. Display and indicator lamp unchanged.	Meter indication is not -10 dB: Trouble is in Input Assembly. See table 7. Display change: Trouble is Assembly A6. See table 6.
6	Set TRF ENABLE switch to OFF. Set ATTENUATOR to 0 dB.	Display indicates approx. 250.00 kHz. BFO indicator lamp on.	Trouble is in display Assembly A6. See table 6.
7	Set ATTENUATOR to -60 dB. Connect ac vtvm to pin 10 of S2 sec. B.	Ac vtvm indicates 30 mV.	Trouble is in Input Assembly. See table 7.
8	Connect ac vtvm to FL3 input	Ac vtvm indicates 11 mV	Trouble is in ATTENUATOR Assembly. See table 9.
9	Reverse input connection applying the signal to E2. Connect ac vtvm to pin 10 of S2 sec. A.	Ac vtvm indicates 30 mV	Trouble is in Input Assembly. See table 7, step 3.
10	Connect ac vtvm to FL3 input.	Ac vtvm indicates 11 mV	Trouble is in ATTENUATOR Assembly. See table 9, step 8.
11	Return input connection to normal, signal to E1 configuration. Note: See table 7 for verification of proper ref. level scaling.		
12	Set INPUT SELECTOR to CAL. Connect ac vtvm to pin 8 on S2 sec. B.	Ac vtvm indicates 0.9 mV.	Trouble is in calibrate oscillator. See table 8.
13	Connect ac vtvm to pin E2 on Assembly A4.	Ac vtvm indicates 6 mV.	Trouble is in FL3 lowpass filter. See table 11.
14	Set RANGE SELECTOR to 0-30. Tune to minimum frequency.	Frequency display goes to 000.000 below 190 Hz.	Frequency remains above 190 Hz: Trouble is in oscillator Assembly A3. See table 11. Display does not switch to 000.000: Trouble is in display Assembly A6. See Table 6.
15	Set RANGE SELECTOR to 30-440. Tune to 250 kHz and obtain 0 dBm meter reading. Set ATTENUATOR to +10 dB. Connect ac vtvm to E6 on Assembly A4.	Ac vtvm indicates 35 mV.	Trouble is in I-F Assembly A4. See table 12.
16	Connect ac vtvm to E10 on Assembly A5. Set MONITOR switch to LSB.	Ac vtvm indicates near 0.05 V.	Trouble is in reinsertion oscillator on Assembly A5. See table 14.
17	Set AUDIO LEVEL to ½ volume. Connect ac vtvm to chassis gnd. and each side of speaker.	Ac vtvm indicates above 0.25 V.	Trouble is in audio amplifier on Assembly A5. See table 14.

Table 5. Charging Control Assembly A9 Trouble Shooting

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Disconnect the unit battery and place a 510 ohm ½ W, load across A9E9 and A9E10. Turn unit on. Set POWER switch to CHARGE.	Voltages for A9E1 thru A9E5 should be within ±0.1 V of the upper values given on schematic, figure 16.	A9E4 shorted to ground or problem is on power supply Assembly A1.
		A9E1 should be 5 V above A9E2.	If difference is equal to 5 V but level is slightly high or low; check A9Q2 collector. Adjust A9R3. If A9E1, A9E2, A9E4 all low: check A9Q1. If A9E1, A9E2, A9E4 all high: check A9Q2.
2	Disconnect the unit battery and place a 100 ohm 3 W, load across A9E9 and A9E10. Turn unit on. Set POWER switch to CHARGE.	Voltages for A9E1 thru A9E5 should be within ±0.1 V of the lower values given on schematic, figure 16.	A9E4 and other voltages low: check A9Q2, A9Q1. Check S3.
3	Set POWER switch to ON.	A9E4 and A9E5 voltages should be equal. A9E1, A9E2, A9E4 voltages should be near those in step 1.	Check S3.
		A9I1 voltages should be within ±0.1 V of the values given on schematic, figure 16.	A9E6 voltage not correct: check A5I1 regulator Check for defective A9I1.

Table 6. Frequency Display Trouble Shooting

It is assumed that the person servicing the instrument has a knowledge of transistors and integrated circuit operation. Appendix A contains descriptions for the digital I-C's used.

Signal levels and wave shapes occurring in the display are shown on the display schematic. Signal at A5P2-4, -9 and -10 consists of a narrow pulse at a very low duty cycle and may be difficult to monitor on an oscilloscope. When applied to a counter input, these signals will generate a 5 cycle per second count.

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Turn unit on. Rotate POWER switch to BAT./LAMP TEST position. Set RANGE SELECTOR switch to 0-30.	Meter reads above 0 dB. Display indicates 8888.88.	If meter indicates below 0 dB: Battery needs recharging. Check POWER switch S3. Check power system A1, A9, A5I1 regulator. If blank display and TRF, BFO indicators: Check A8E1 voltage level. If no change in display: Check A8E18 for a lo level. If all segments change state: Check A8P1-2 for hi level. Unlit segment in all three right hand digits: Verify the associated A7I2 segment output is less than 2 V. Verify associated resistors A8R4 thru A8R10 are not open. Unlit segment in all three left hand digits: Verify the associated A7I7 segment output is less than 2 V. Verify associated resistors A8R15 thru A8R21 are not open.

Table 6. Frequency Display Trouble Shooting (cont.)

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
			Two digits blank: Check associated transistor A7Q1, A7Q2, A7Q3 or A7I1 $\overline{DS}$ output.
			Two digits lit: Check A8P2-11 and A7I1 DS outputs, see waveshapes in detail B on schematic figure 17.
			Unlit segments not common to half of the display: Replace defective readout.
2	Set TRF ENABLE switch to ON. Rotate POWER switch to BAT./LAMP TEST position.	TRF indicator lamp on.	If no indication, check A8I6 pin 13, lamp DS2, A8Q6.
			If BFO indicator lamp is on: Check TRF ENABLE switch S4 for proper DC levels and switch operation.
			If S4 red wire always near 7.5 V: Verify grounding A8E4 input line is detected by instrument meter. Check A8R17 adjustment, check A8I3a. Verify step 4 operation, if step 4 performance is normal, check A8I6b.
3	Set TRF ENABLE switch to OFF. Rotate POWER switch to BAT./LAMP TEST position.	BFO indicator lamp on.	CHECK TRF ENABLE switch S4 for proper DC levels and switch operation.
			Check A8I6 pin 12, lamp DS1, A8Q5.
4	Set POWER switch to ON. Tune the instrument over the 30-440 kHz frequency range.	A stable frequency display over the tuned range.	0000.00 display: Check emitter of Q1 for 70 mV or greater signal. If no signal, go to table 11.
			Check signal at A7P2 pin 2. Signal should provide a stable 15 kHz to 220 kHz frequency reading on a frequency counter. If frequency readings unstable or out of range, check A8I13a, A8I11a, A8I5b, A8I5a, A8I4b, A8I1, A8I25, A8Q2 and A8Q3.
			If A7P2 pin 2 OK, check A7P2 pins 4, 9 and 10 for pulses at a 5 Hz rate conforming to Detail A on schematic, figure 17. If signals not correct, check A8I25, A8Q2, A8I8, A8I9, A8I10, A8I12, A8I13, A8I14, A8I11b, A8I7a and A8I7c.
5	Provide the unit with an input signal in the 30-440 kHz range, tune the instrument for a -10 dB meter indication. Set the TRF ENABLE switch to ON.	TRF display of Input signal.	No TRF indications: Check A8I6, A8I5a and A8I2. Inaccurate TRF Display: Set the TRF ENABLE switch to OFF and check accuracy of 1,102.5 kHz signal at A8TP1.
6	Monitor the pulse rate of the output from the Counter Output Bd. A10.	The average pulse rate of the Counter Output shall be the input signal frequency.	Check A10I1 and A10I2.
7	Tune the instrument away from the input frequency.	Display shall switch to a BFO display as the level reading drops. Switching shall take place between -10 and -15 dBm readings.	No switch to BFO display: Check S4, A8I3a, A8I6a and A8I6b. Adjust A8R17 to set switching level. BFO display 10 kHz high: Check A8I20 and A8I21c.
8	Repeat step 4 and 5 for the 440-1500 range.	Same as step 4 and 5.	Same as steps 4 and 5 except A7P2 pin 2 frequencies will be 220 kHz to 750 kHz.

Table 6. Frequency Display Trouble Shooting (cont.)

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
9	Set the RANGE SELECTOR switch to 0-30. Set SELECTIVITY switch to MEASURE. Tune over the frequency range.	Stable display of frequencies above 200 Hz. Display switches to all 0's below about 190 Hz. Decimal point switched for 1 Hz resolution.	Check A3S1 (section A), A8I7b, A8I15a, A8I15c, A8I16, A8I17b, A8I18, A8I22, A8I21b, A8I24, A8I3b, A8I23. Frequencies below 180 Hz displayed: Check A8I19, A8I15b, A8I18b, A8I14a and A8I17a. Decimal point incorrect: Check A3S1 (section A), A7Q4, A7Q5 and A7I6 pins 1 and 15.
10	Provide the unit with an input signal in the 0-30 kHz range, tune the instrument for a greater than -10 dBm meter indication. Set the TRF ENABLE switch to On. Monitor the frequency of the output from the Counter Output Board A10.	The average frequency of the counter output shall be the input signal frequency.	Check A10I1 and A10I2.

Table 7. Input Assembly Trouble Shooting

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Set signal generator for 0.78 V output. Connect ac vtvm to pin 10 of S2 sec. B.	Ac vtvm indicates 29.5 mV.	Check R1, C1 and S2 connections.
2	Verify proper voltage scaling for all Input Selector positions.	POSITION / VOLTAGE CAL. 0.93 mV Volts 29.5 mV 600Ω 29.5 mV 135Ω 62.2 mV 75Ω 32.3 mV 50Ω 26.4 mV	Check S2 sec. B. and Sec. C connections for CAL position. See table 8.
3	Reverse input connection applying the input signal to E2. Connect ac vtvm to pin 10 of S2 sec. A. Set Input Selector to 600Ω or volts.	Ac vtvm indicates 29.5 mV.	Check R2, C2 and S2 connections.
4	Verify proper voltage scaling for Input Selector positions.	POSITION / VOLTAGE CAL. 0.0 Volts 29.5 mV 600Ω 29.5 mV 135Ω 62.2 mV 75Ω 32.3 mV 50Ω 26.4 mV	Check S2 sec. A connections.
5	Return input connection to original configuration, i.e. signal to E1.		

Table 8. Calibrate Oscillator Assembly A11 Trouble Shooting

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Set INPUT SELECTOR to CAL. Connect ac vtvm to pin 8 on S2 sec. B.	Ac vtvm indicates approx. 0.93 mV	Adjust A11R5 to correct output level according to paragraph 4. "Alignment". Check A11I1 pin 14 for +5.0 V. Check A11I1 pins 10 and 4 for 250 kHz signal.

Table 9. ATTENUATOR Assembly AT1 Trouble Shooting

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Set the signal generator for a -60 dBm 600 ohms output. With the Input Selector set to 600 ohms tune the unit for a peak meter reading. Adjust the CAL LEVEL for a 0 dBm meter reading.	0 dBm reading attainable.	Check AT1 S1 connections. Check A2 transistor voltages. See table 15.
2	Increase the unit Attenuator setting by 10 dB. Increase the signal generator output by 10 dB.	0 dBm meter reading.	Check AT1S1 connections.
3	Continue performing step 2 until limited by generator output capability.		
4	Reduce signal generator output by 28.5 dB. Connect the signal generator output to the junction of R1 and C1.	0 dBm meter reading ±0.5 dBm.	Input Assembly is faulty. Go to table 7.
5	Adjust the CAL LEVEL for a 0 dBm meter reading.	0 dBm reading attainable.	Input Assembly is faulty. Go to table 7.
6	Increase the unit Attenuator setting by 10 dB. Increase the signal generator output by 10 dB.	0 dBm meter reading.	Check AT1S1 connections.
7	Continue performing step 6 until the +40 dBm ATTENUATOR setting has been checked.		
8	Reverse the input connection applying the input signal to E2. Repeat steps 1 thru 7 for step 4 connect the signal generator output to R2 and C2.		

Table 10. Lowpass Filter FL3 Trouble Shooting

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Set signal generator to 250 kHz at 24.5 mV and connect to IN on FL3. Connect ac vtvm to OUT on FL3.	Ac vtvm indicates 25.0 mV.	Check continuity of FL3.
2	Connect ohmmeter from pin IN to OUT on FL3.	Ohmmeter indicates less than 1 ohm.	Trouble is in FL3.

Table 11. Local Oscillator Assembly A3 Trouble Shooting

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Connect ac vtvm to base of A3Q1.	Ac vtvm indicates between 0.15 and 0.4 V.	Check A3Q2 voltages. See table 15.
2	Connect ac vtvm to anode of A3CR1b.	Ac vtvm indicates 0.8 V.	Check A3Q1 and A3Q2 voltages. See table 15.

Table 12. I-F Amplifier Assembly A4 Trouble Shooting

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Set signal generator to 2,215 kHz at -100 dB (7.75 μV) and connect to E2 on Assembly A4. Rotate CAL LEVEL fully ccw. Set SELECTIVITY to MONITOR.	Instrument indicates between -10 dB to 0 dB.	Adjust A4T1, A4T2 and A4T3 for maximum indication on meter. Check A4Q1 thru A4Q8 voltages. See table 15.

Table 13. Reinsertion Oscillator Assembly A5 Trouble Shooting

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Set MONITOR to LSB. Connect ac vtvm to drain of A5Q1.	Ac vtvm indicates 2.2 V	Check A5Q1 voltages. See table 15. Check crystals.
2	Connect ac vtvm to collector of A5Q2.	Ac vtvm indicates 0.7 V.	Check A5Q2 voltages. See table 15.

Table 14. Audio Amplifier Assembly A5 Trouble Shooting

STEP	PROCEDURE	NORMAL INDICATION	IF INDICATION IS ABNORMAL
1	Set signal generator to 1 kHz at 11 mV and connect to E10 on Assembly A5. Rotate AUDIO LEVEL control R12 fully cw. Connect ac vtvm to chassis gnd. and each side of speaker.	Ac vtvm indicates greater than 1.7 V.	Check A5I2 voltages. See table 16.

Table 15. Transistor Voltage Chart

Connect instrument to ac power line and set controls as follows:

1. No signal input
2. CAL LEVEL fully cw
3. MONITOR to LSB
4. INPUT SELECTOR to CAL

Readings taken with vtvm and should be ±10%.
All voltages positive with respect to chassis ground.

ASSEMBLY	TRANSISTOR	EMITTER	BASE	COLLECTOR
CHASSIS	Q1	8.5	9.1	9.3
A2	Q1	Source = 2	Gate = 1.5	Drain = 8.5
	Q2	Source = 2	Gate = 1.5	Drain = 8.5
	Q3	5.0	5.7	8.5
	Q4	3.5	2.8	0
A3	Q1	1.8	2.2	6.2
	Q2	1.6	1.9	7.8
A4	Q1	2.9	3.5	8.5
	Q2	2.2	2.9	8.5
	Q3	1.1	1.8	4.5
	Q4	1.8	2.5	8.9
	Q5	1.2	1.8	4.6
	Q6	2.2	2.9	9.3
	Q7	0.9	1.6	9.2
	Q8	1.6	2.3	5.1
A5	Q2	7.8	7.4	1.5
	Q1	Source = 0.8	Gate = 0	Drain = 5.6

Table 16. Linear Integrated Circuit Voltages

Test Conditions are same as those given in table 15.
N.C. = No connection. N.D. = Not definite.

INTEGRATED CIRCUIT	PINS 1	2	6	7	8	9	13	14
A5I2	6.8	6.7	6.8	6.8	6.8	6.8	6.7	13.5
	Note: Pins 3, 4, 5, 10, 11 and 12 = 0							

INTEGRATED CIRCUIT	PINS 1	2	3	4	5	6	7	8
A8I1	1.5	0	1.5	N.C.	6.9	7.5	7.0	N.C.
A8I2	0	3.8	3.8	0	N.C.	N.C.	Sig.	7.5
A8I3	6.0 or 0	0	0.007	0	3.8	N.D.	N.D.	7.5
A8I25	1.5	0	1.5	N.C.	6.9	7.5	7.0	N.C.

3. ALIGNMENT

a. **Calibrate Oscillator.** Due to normal aging, or replacement of parts, it may be necessary to calibrate the voltmeter. This is accomplished by comparing the calibrate oscillator output level with a known external source. Connect the equipment as shown in figure 3, then proceed with steps (1) through (8).

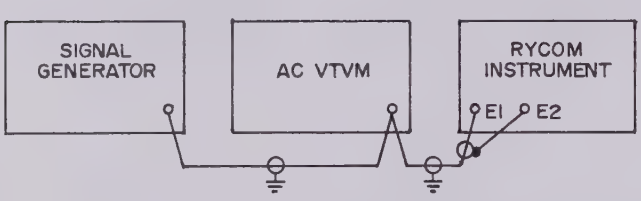

Figure 3
Test Setup for Level Calibration

(1) Set the instrument and controls as follows:

Switch/Control	Position
INPUT SELECTOR	600Ω
SELECTIVITY	MEASURE
ATTENUATOR	CAL -30 dB
RANGE SELECTOR	30-440 kHz
TUNING	250 kHz indication on readout display
TRF ENABLE	OFF

(2) Adjust signal generator frequency to 250 kHz.
(3) Adjust signal generator output level to -30 dBm (24.5 mV).
(4) Adjust TUNING control for maximum indication on meter.
(5) Adjust CAL LEVEL for 0 dBm indication on meter.
(6) Set INPUT SELECTOR to CAL.
(7) Adjust TUNING control for maximum indication on meter.
(8) Adjust CAL OSC ADJ control A11R5 on Assembly A11 for a CAL indication on meter, (A11 is mounted on the INPUT SELECTOR switch S2. A11R5 is accessible from the bottom of an uncased unit.) The instrument is now calibrated and ready for operation.

b. **I-F Amplifier.** The alignment of the 2,215-kHz I-F amplifier, Assembly A4, is performed by using the internal 250-kHz calibrate oscillator as a signal source. Proceed as follows:

(1) Set the instrument and controls as follows:

Switch/Control	Position
INPUT SELECTOR	CAL
ATTENUATOR	CAL -30 dB
SELECTIVITY	MEASURE
RANGE SELECTOR	30-440 kHz
TUNING	Adjust for maximum meter indication

NOTE
Assembly A4 cover must be in place before aligning.

(2) Adjust CAL LEVEL (and A4R5 if needed) so meter indicates in upper one half of scale.
(3) Adjust A4T1, A4T2 and A4T3 with a non-metallic tuning tool for maximum meter indication.
(4) Set the ATTENUATOR to -20 dB. Adjust CAL LEVEL fully clockwise (maximum gain) and adjust A4R5 for a 3 dBm below CAL meter indication. This means maximum gain will be 7.0 dB above the nominal CAL Level.
(5) Check gain range by rotating CAL LEVEL to extreme counter-clockwise position (minimum gain). Meter should indicate approximately -6 dB with ATTENUATOR switch set to -30 dB.

NOTE: An alternate setting of A4R5 may be required to obtain both a stable TRF frequency display at a -10 dBm meter reading and intermodulation products more than -55 dB below the reference signals. Increasing I-F gain with A4R5 will tend to stabilize a TRF frequency display. Reducing I-F gain with A4R5 will reduce the level of intermodulation products.

c. **Crystal Filters A4FL1 and A4FL2.** Crystal filters A4FL1 and A4FL2 on assembly A4 can be adjusted for passband flatness by using the internal calibrate oscillator. Proceed as follows:

(1) Set the instrument and controls as follows:

Switch/Control	Position
INPUT SELECTOR	CAL
ATTENUATOR	CAL -30 dB
SELECTIVITY	MONITOR
RANGE SELECTOR	30-440 kHz
TUNING	250 kHz indication on readout display

(2) Adjust TUNING so meter indicates in valley of passband ripple.
(3) Adjust A4C9 and A4C10 for maximum meter indication.
(4) Repeat steps (2) and (3) until filter A4FL2 passband ripple is within ±0.5 dB.
(5) Set SELECTIVITY to MEASURE.
(6) Adjust TUNING for maximum meter indication.
(7) Adjust A4C7 and A4C8 for maximum meter indication.
(8) Repeat steps (6) and (7) until A4FL1 filter has a rounded peak response with no ripple.
(9) Set the instrument ATTENUATOR to -60 dB. Tune both above and below the measure filter center frequency. Note the highest level reading to which the instrument returns after passing through the first -50 dBm points (-80 dBm referenced to -30 dBm). If the level is above a -50 dB rejection level (-80 dBm referenced to -30 dBm), adjust A4C7 and A4C8 as required to obtain fallback levels below the -50 dB rejection level.

d. **Local Oscillator and Frequency Display Adjustment.**
(1) Connect the equipment as shown in figure 4.
(2) Adjust the equipment as follows:

Switch/Control	Position
Signal Generator	0 dBm (600Ω) level output at 1,500.00 kHz
INPUT SELECTOR	600Ω
ATTENUATOR	0 dB
SELECTIVITY	MONITOR
TRF ENABLE	ON
RANGE SELECTOR	440-1500 kHz

(3) Tune the instrument for a TRF display of the 1,500.00 kHz input.
(4) Adjust A8C4 to obtain a 1,500.00 kHz display
(5) Tune the instrument for a maximum frequency display Set the RANGE SELECTOR to each of the three frequency ranges and verify the maximum frequency is above the specified limit for the range.
(6) Tune the instrument for a minimum frequency display. Set the RANGE SELECTOR to each of the three frequency ranges and verify the minimum frequency is below the lower limit for the range. For the 0-30 kHz range, set the SELECTIVITY switch to MEASURE, the instrument should tune thru a peak level reading with an all 0's display. This is to provide for a 200 Hz minimum at extreme temperatures.
(7) Adjust A3L3 to shift frequencies for all ranges. Adjust A3C14 to shift only the 0-30 range frequencies.

Note

For an alternate high accuracy frequency calibration, proceed as follows:

Monitor the frequency at A8TP1. This test point is accessible through a hole in the top of the A6 display assembly cover. Set the TRF ENABLE switch to OFF. Adjust A8C4 for an accurate 1,102.500 kHz reference oscillator frequency.

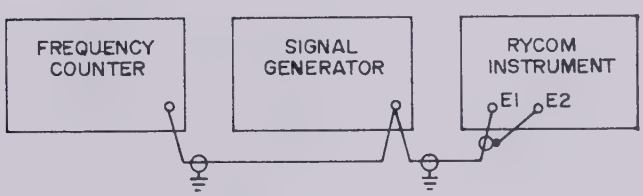

Figure 4
Test Setup for Frequency Alignment

CHAPTER V
PARTS LIST

1. HOW TO ORDER PARTS.

When ordering parts, always include:

a. Name, Model and Serial Number of the instrument.
b. Module and reference designation.
c. Part number.
d. Description.

Order parts from:

RYCOM INSTRUMENTS INC.
9351 East 59th Street
Raytown, Missouri 64133 Telephone 816-353-2100

NOTE: $35.00 minimum on all orders, subject to change without notice.

PARTS LIST

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
	PARTS LOCATED ON FRONT PANEL OR CHASSIS		
BT1	Battery, 12 volt, rechargeable	770 00008 01	1
C1	Cap, 1.0 μF ±20%, 400 wvdc, mylar	620 00023 05	2
C2	Cap, 1.0 μF, same as C1		ref
C3	Cap, Feed-thru, 1000 pF	680 00003 00	1
C4	Cap, var. air, 11-150 pF, type L	650 00002 02	1
C5	Cap 0.1 μF, ±10%, 50 wvdc, mono	600 00015 01	2
C6	Cap, 0.1 μF, same as C5		
C7	Cap 22 μF ±20%, 16 wvdc, tantalum	640 00001 05	1
E1	Binding Post, Red	812 00038 00	2
E2	Binding Post, Red, same as E1		ref
E3	Binding Post, Black	812 00038 01	1
E4	Terminal, Feed-thru	810 00006 01	1
E5	Terminal, Standoff	810 00005 01	1
A4FL1	Filter, bandpass, 2215 kHz, 50-Hz BW (used in units with 50-Hz selectivity)	760 00007 01	1
A4FL1	Filter, bandpass, 2215 kHz, 100-Hz BW (used in units with 100-Hz selectivity)	760 00006 01	1
A4FL1	Filter, bandpass, 2215 kHz, 250-Hz BW (used in units with 250-Hz selectivity)	760 00005 01	1
A4FL2	Filter, bandpass, 2215 kHz, 2500-Hz BW (used in units with 2500-Hz selectivity)	760 00004 01	1
A4FL2	Filter, bandpass, 2215 kHz, 3100-Hz BW (used in units with 3100-Hz selectivity)	760 00009 01	1
FL3	Filter, lowpass, 1.55 MHz cutoff frequency, 150 ohms input and output inpedance	761 00005 00	1
J1	Connector, electrical, power	812 00066 00	1
J2	Jack, phone	812 00009 00	1
J3	NOT USED		
J4	Jack, phono	812 00056 00	1
J5	Connector BNC	812 00065 01	1
L1	Coil, rf, 15.6 μH	701 00008 03	1
L2	Suppressor, parasitic	701 00005 00	1
L3	Suppressor, parasitic	701 00041 00	1
L4	Suppressor, parasitic	701 00020 00	1
L5	Suppressor, parasitic	701 00024 00	1
L6	Coil, rf, 100 μH	701 00032 05	2
L7	Coil, rf, 100 μH, same as L6		ref
LS1	Loudspeaker, 3 inch	743 00003 00	1
M1	Meter, 200 μA, 3.5 inch	740 00011 00	1

PARTS LIST

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
P1	NOT USED		
P2	NOT USED		
P3	Plug Assembly	152 05011 00	1
P4	Plug Assembly	152 05012 00	1
Q1	Transistor, NPN, silicon, type 2N3704	400 00013 00	1
R1	Res, 22.6 k ohms ±1%, ½ W, 70° C, film	511 52262 00	2
R2	Res, 22.6 k ohms, same as R1		ref
R3	Res, 2.2 Meg ohms ±5%, ¼ W	500 00225 00	1
R4	Res, 3.24 k ohms ±1%, ⅛ W, 70°C, film	511 23241 00	2
R5	Res, 3.24 k ohms, same as R4		ref
R6	Res, 1.62 k ohms, ±1%, ⅛ W, 70°C, film	511 21621 00	2
R7	Res, 1.62 k ohms, same as R6		ref
R8	Res, 47 ohms ±5%, ½ W, carbon	502 00470 00	1
R9	Res, 10 k ohms ±5%, ¼ W, carbon	500 00103 00	1
R10	Res, 71.5 k ohms ±1%, ⅛ W, 70° C, film	511 27152 00	1
R11	Res, var. 10 k ohms ±30%, ½ W,	540 00001 10	1
R12	Res, var. 25 k ohms ±30%, 1$3 W,	540 00001 15	1
R13	Res, 1.33 k ohms ±1%, ⅛ W, 70°C, film	511 21331 00	2
R14	Res, 1.33 k ohms, same as R13		ref
R15	Res, 1.96 k ohms ±1%, ⅛ W, 70°C, film	511 21961 00	2
R16	Res, 1.96 k ohms, same as R15		ref
S1	NOT USED		
S2	Switch, rotary	720 00054 00	1
S3	Switch, rotary	720 00044 00	1
S4	Switch, toggle, SPDT	722 00002 00	1
WA1	Cord Assembly, power	151 00025 00	1
	ATTENUATOR ASSEMBLY AT1 **The Attenuator Assembly consists of Circuit Card Assembly A2 and the following:**		
AT1L8	Parasitic Suppressor	701 00042 00	1
AT1R1	Res, 4990 ohms ±1%, ⅛ W,	511 24991 00	8
AT1R2	Res, 15.8 ohms ±1%, ⅛ W,	511 21588 00	4
AT1R3	Res, 4990 ohms, same as AT1R1		ref
AT1R4	Res, 49.9 ohms ±1%, ⅛ W,	511 24998 00	2
AT1R5	Res, 4870 ohms ±1%, ⅛ W,	511 24871 00	2
AT1R6	Res, 158 ohms ±1%, ⅛ W,	511 21580 00	2
AT1R7	Res, 4530 ohms ±1%, ⅛ W,	511 24531 00	2
AT1R8	Res, 499 ohms ±1%, ⅛ W,	511 24990 00	2
AT1R9	Res, 3400 ohms ±1%, ⅛ W,	511 23401 00	2
AT1R10	Res, 1580 ohms ±1%, ⅛ W,	511 21581 00	2
AT1R11	Res, 4990 ohms, same as AT1R1		ref
AT1R12	Res, 4990 ohms, same as AT1R1		ref
AT1R13	Res, 15.8 ohms, same as AT1R2		ref
AT1R14	Res, 4990 ohms, same as AT1R1		ref
AT1R15	Res, 15.8 ohms, same as AT1R2		ref
AT1R16	Res, 4990 ohms, same as AT1R1		ref
AT1R17	Res, 49.9 ohms, same as AT1R4		ref
AT1R18	Res, 4870 ohms, same as AT1R5		ref
AT1R19	Res, 158 ohms, same as AT1R6		ref
AT1R20	Res, 4530 ohms, same as AT1R7		ref
AT1R21	Res, 499 ohms, same as AT1R8		ref
AT1R22	Res, 3400 ohms, same as AT1R9		ref
AT1R23	Res, 1580 ohms, same as AT1R10		ref
AT1R24	Res, 4990 ohms, same as AT1R1		ref
AT1R25	Res, 4990 ohms, same as AT1R1		ref
AT1R26	Res, 15.8 ohms, same as AT1R2		ref
AT1S1	Switch, rotary 11-pos	720 00036 00	1

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
	POWER SUPPLY ASSEMBLY A1		
A1C1	Cap, 220 μF (+100, -10%), 50 wvdc, elect'c	630 00005 08	1
A1C2	Cap 0.1 μF (+80, -20%), 25 wvdc, ceramic	600 00006 12	1
A1CR1	Rectifier, Bridge, 200 PIV, 2 A	410 00025 00	1
A1R1	Fuse Holder	813 00009 00	1
	Fuse 3AG 3/16 Amp slo-blow (used in units with 115 vac operation)	723 00001 01	1
	Fuse 3AG 1/10 Amp slo-blow (used in units with 230 vac operation)	723 00001 00	1
A1I1	Integrated Circuit, LM309K	431 00020 01	1
A1S1	Switch, 115/230 vac	721 00009 00	1
A1T1	Transformer, power, 115/230 vac	700 00040 00	1
	SUMMING AMPLIFIER ASSEMBLY A2		
A2	Circuit Card Assy, Summing Amplifier	110 00081 02	
A2C1	Cap, 0.1 μF ±10%, 50 wvdc, mono	600 00015 01	2
A2C2	Cap, 0.1 μF, same as A2C1		ref
A2C3	Cap, 10 μF ±20%, 15 wvdc tantalum	640 00001 01	4
A2C4	Cap, 10 μF, same as A2C3		ref
A2C5	Cap, 10 μF, same as A2C3		ref
A2C6	Cap, 10 μF, same as A2C3		ref
A2Q1	Transistor, FET, 2N5484 selected	400 00001 01	2
A2Q2	Transistor, 2N5484, same as A2Q1		ref
A2Q3	Transistor, NPN, 2N3704	400 00013 00	1
A2Q4	NOT USED		
A2Q5	Transistor, PNP, 2N3702	400 00012 00	1
A2R1	Res, 1 Meg ohm ±5%, ¼ W, carbon	500 00105 00	2
A2R2	Res, 1 Meg ohm, same as A2R1		ref
A2R3	Res, var, 2000 ohms ±10%, ½ W, carbon	542 00003 02	1
A2R4	Res, 1000 ohms ±5%, ¼ W, carbon	500 00102 00	1
A2R5	Res, 5100 ohms ±5%, ¼ W, carbon	500 00512 00	3
A2R6	Res, 5100 ohms, same as A2R5		ref
A2R7	Res, 5100 ohms, same as A2R5		ref
A2R8	Res, 100 ohms ±5%, ¼ W, carbon	500 00101 00	3
A2R9	Res, 100 ohms, same as A2R8		ref
A2R10	NOT USED		
A2R11	Res, 100 ohms, same as A2R8		ref
A2R12	Res, 130 ohms ±5%, ¼ W, carbon	500 00131 00	1
A2R13	Res, 47 ohms ±5%, ¼ W, carbon	500 00470 00	1
A2R14	Res, 22 ohms ±5%, ¼ W, carbon	500 00220 00	1
A2R15	Res, 4.7 Meg ohms ±5%, ¼ W, carbon	500 00475 00	2
A2R16	Res, 4.7 Meg ohms, same as A2R15		ref
	LOCAL OSCILLATOR ASSEMBLY A3		
A3	Circuit Card Assy, Local Osc	110 00094 00	
A3C1	Cap, 0.1 μF (+80, -20%), 25 wvdc, ceramic	600 00003 12	4
A3C2	Cap 22 pF ±5%, 100 wvdc, silver mica	610 20022 21	1
A3C3	Cap, 0.1 μF, same as A3C1		ref
A3C4	Cap, 0.1 μF, same as A3C1		ref
A3C5	Cap, 0.1 μF, same as A3C1		ref
A3C6	Cap, 0.01 μF (+80, -20%) 25 wvdc ceramic	600 00003 00	1
A3C7	Cap, 1500 pF ±5%, 100 wvdc, silver mica	611 21500 21	1
A3C8	Cap, 4000 pF ±5%, 100 wvdc, silver mica	611 24000 21	1
A3C9	Cap, 22 pF ±5%, 500 wvdc, N750, ceramic	601 00003 24	1
A3C10	Cap, 51 pF ±5%, 500 wvdc, NPO, ceramic	601 00003 26	1
A3C11	Cap, 155 pF ±5%, 200 wvdc, N080, ceramic	601 00005 06	1
A3C12	Cap 0 to 10 pF ±5%, NPO, ceramic, when required	601 Series	
A3C13	Cap 100 pF ±5%, 500 wvdc, N220, ceramic	601 00003 27	1

PARTS LIST

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
A3C14	Cap, var, 2.2-34 pF, air dielectric	650 00006 00	1
A3C15	Cap, 180 pF ±5%, 500 wvdc, NPO, ceramic	601 00003 11	1
A3C16	Cap 27 pF ±5%, 500 wvdc, NPO, ceramic	601 00003 04	1
A3CR1	Diodes, Matched Set	715 00001 01	1
A3L1	Coil, rf, 1.0 mH	701 00017 02	1
A3L2	Coil, rf, 150 μH	701 00015 00	2
A3L3	Coil, rf, var, 2.5-5 μH	701 00007 01	1
A3L4	Coil, rf, 150 μH, same as A3L2		ref
A3Q1	Transistor, NPN, BC169B	400 00029 00	2
A3Q2	Transistor, same as A3Q1		ref
A3R1	Res, 57.6 ohms ±1%, 1/10 W, 125° C, film	511 25768 10	2
A3R2	Res, var, 20 ohms 20 turn, cermet	542 00009 00	1
A3R3	Res, 57.6 ohms, same as A3R1		ref
A3R4	Res, 680 ohms ±5%, ¼ W, carbon	500 00681 00	1
A3R5	Res, 3300 ohms ±5%, ¼ W, carbon	500 00332 00	1
A3R6	Res, 1000 ohms ±5%, ¼ W, carbon	500 00102 00	3
A3R7	Res, 47 ohms ±5%, ¼ W, carbon	500 00470 00	1
A3R8	Res, 10 k ohms ±5%, ¼ W, carbon	500 00103 00	2
A3R9	Res, 10 k ohms, same as A3R8		ref
A3R10	Res, 2700 ohms ±5%, ¼ W, carbon	500 00272 00	1
A3R11	Res, 1000 ohms, same as A3R6		ref
A3R12	Res, 1000 ohms, same as A3R6		ref
A3S1	Switch, rotary, detent with sec A	720 00037 00	1
A3S1	Switch wafer, sec B only	720 00023 01	1
A3T1	Transformer, balanced demodulator	700 00052 01	1
	I-F ASSEMBLY A4		
A4	Circuit Card Assy, I-F	110 00155 00	1
A4C1	Cap, 0.01 μF ±10%, 50 wvdc, mono	600 00015 02	8
A4C2	Cap, 0.01 μF, same as A4C1		
A4C3	Cap, 0.1 μF ±10%, 50 wvdc, mono	600 00015 01	9
A4C4	Cap, 0.1 μF, same as A4C3		
A4C5	Cap, 0.01 μF, same as A4C1		
A4C6	Cap, 0.01 μF, same as A4C1		
A4C7	Cap, var. 5-25 pF, 350 wvdc, NPO ceramic	660 00003 02	4
A4C8	Cap, var. 5-25 pF, same as A4C7		
A4C9	Cap, var. 5-25 pF, same as A4C7		
A4C10	Cap, var. 5-25 pF, same as A4C7		
A4C11	Cap, 68 pF ±5%, 100 wvdc, silver mica	610 20068 21	1
A4C12	Cap, 0.001 μF ±10%, 50 wvdc, mono	600 00015 03	3
A4C13	Cap, 0.1 μF, same as A4C3		
A4C14	Cap, 0.1 μF, same as A4C3		
A4C15	Cap, 0.01 μF, same as A4C1		
A4C16	Cap, 0.001 μF, same as A4C12		
A4C17	Cap, 0.1 μF, same as A4C3		
A4C18	Cap, 0.01 μF, same as A4C1		
A4C19	Cap, 0.1 μF, same as A4C3		
A4C20	Cap, 0.1 μF, same as A4C3		
A4C21	Cap, 0.01 μF, same as A4C1		
A4C22	Cap, 0.1 μF, same as A4C3		
A4C23	Cap, 1 μF ±20%, 35 wvdc, tantalum	640 00001 03	1
A4C24	Cap, 0.1 μF, same as A4C3		
A4C25	Cap, 0.01 μF, same as A4C1		
A4C26	Cap, 0.001 μF, same as A4C12		
A4CR1	Diode, germanium, 1N277	410 00005 00	1
A4CR2	Diode, silicon, 1N914A	410 00015 00	1
A4I1	IC, DIP, type 358	431 00054 00	1
A4L1	Coil, rf, 1.0 mH 34 ohms dc res	701 00017 02	4

PARTS LIST

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
A4L2	Coil, rf, 1.0 mH, same as A4L1		
A4L3	Coil, rf, 1.0 mH, same as A4L1		
A4L4	Coil, rf, 1.0 mH, same as A4L1		
A4Q1	Transistor, NPN, 2N4124	400 00018 00	6
A4Q2	Transistor, NPN, 2N4124, same as A4Q1		
A4Q3	Transistor, NPN, BC169B	400 00029 00	2
A4Q4	Transistor, NPN, 2N4124, same as A4Q1		
A4Q5	Transistor, NPN, 2N4124, same as A4Q1		
A4Q6	Transistor, NPN, 2N4124, same as A4Q1		
A4Q7	Transistor, NPN, 2N4124, same as A4Q1		
A4Q8	Transistor, NPN, BC169B, same as A4Q3		
A4R1	Res, 200 ohms ±5%, ¼ W, carbon	500 00201 00	1
A4R2	Res, 6200 ohms ±5%, ¼ W, carbon	500 00622 00	1
A4R3	Res, 4300 ohms ±5%, ¼ W, carbon	500 00432 00	1
A4R4	Res, 10 k ohms ±5%, ¼ W, carbon	500 00103 00	5
A4R5	Res, var. 200 ohms ±20%, ½ W, carbon	542 00007 00	1
A4R6	Res, 390 ohms ±5%, ¼ W, carbon	500 00391 00	3
A4R7	Res, 10 k ohms, same as A4R4		
A4R8	Res, 2700 ohms ±5%, ¼ W, carbon	500 00272 00	2
A4R9	Res, 3900 ohms ±5%, ¼ W, carbon	500 00392 00	2
A4R10	Res, 910 ohms ±5%, ¼ W, carbon	500 00911 00	1
A4R11	Res, 160 ohms ±5%, ¼ W, carbon	500 00161 00	1
A4R12	Res, 1100 ohms ±5%, ¼ W, carbon	500 00112 00	1
A4R13	Res, 47 k ohms ±5%, ¼ W, carbon	500 00473 00	1
A4R14	Res, 18 k ohms ±5%, ¼ W, carbon	500 00183 00	2
A4R15	Res, 10 k ohms, same as A4R4		
A4R16	Res, 3900 ohms, same as A4R9		
A4R17	Res, 1000 ohms ±5%, ¼ W, carbon	500 00102 00	3
A4R18	NOT USED		
A4R19	Res, 10 k ohms, same as A4R4		
A4R20	Res, 4700 ohms ±5%, ¼ W, carbon	500 00472 00	1
A4R21	Res, 1000 ohms, same as A4R17		
A4R22	Res, 10 k ohms, same as A4R4		
A4R23	Res, 2200 ohms ±5%, ¼ W, carbon	500 00222 00	1
A4R24	Res, 390 ohms, same as A4R6		
A4R25	Res, 18 k ohms, same as A4R14		
A4R26	Res, 20 k ohms ±5%, ¼ W, carbon	500 00203 00	2
A4R27	Res, 200 k ohms ±5%, ¼ W, carbon	500 00204 00	1
A4R28	Res, 20 k ohms, same as A4R26		
A4R29	Res, 3300 ohms ±5%, ¼ W, carbon	500 00332 00	1
A4R30	Res, 2700 ohms, same as A4R8		
A4R31	Res, 390 ohms, same as A4R6		
A4R32	Res, 680 ohms ±5%, ¼ W, carbon	500 00681 00	1
A4R33	Res, selected as required	500 series	1
A4R34	Res, selected as required	500 series	1
A4R35	Res, 10 ohms ±5%, ¼ W, carbon	500 00100 00	1
A4R36	Res, 100 ohms ±5%, ¼ W, carbon	500 00101 00	3
A4R37	Res, 22 ohms ±5%, ¼ W, carbon	500 00220 00	1
A4R38	Res, 100 ohms, same as A4R36		
A4R39	Res, 150 ohms ±5%, ¼ W, carbon	500 00151 00	1
A4R40	Res, 5100 ohms ±5%, ¼ W, carbon	500 00512 00	1
A4R41	Res, 100 ohms, same as A4R36		
A4R42	Res, 1000 ohms, same as A4R17		
A4R43	Res, 1.5 Meg ohms ±5%, ¼ W, carbon	500 00155 00	1
A4S1	Switch, rotary, wafer only	720 00019 01	1
A4T1	Transformer, I-F, 2215 kHz	700 00054 00	3
A4T2	Transformer, 2215 kHz, same as A4T1		
A4T3	Transformer, 2215 kHz, same as A4T1		

PARTS LIST

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
	MONITOR ASSEMBLY A5		
A5	Circuit Card Assy, Monitor	110 00079 01	
A5C1	Cap, 0.1 μF ±10%, 50 wvdc, mono	600 00015 01	2
A5C2	Cap, 10 μF, ±20%, 15 wvdc, tantalum	640 00001 01	1
A5C3	Cap, 180 pF ±1%, 100 wvdc, mica	610 20180 01	1
A5C4	Cap, 0.1 μF, same as A4C1		ref
A5C5	Cap, 75 pF ±1%, 100 wvdc, mica	610 20075 01	1
A5C6	Cap, 0.01 μF ±10%, 50 wvdc, mono	600 00015 02	4
A5C7	Cap, 0.01 μF, same as A5C6		ref
A5C8	Cap, 0.01 μF, same as A5C6		ref
A5C9	Cap, 0.01 μF, same as A5C6		ref
A5C10	Cap, 1 μF ±20%, 35 wvdc, tantalum	640 00001 03	1
A5C11	Cap, 22 μF, (+50, -10%) 16 wvdc alum elct'c	630 00001 01	1
A5C12	Cap, 22 μF, 35 wvdc, alum elect'c	630 00004 00	1
A5CR1	Diode, germanium, 1N277	410 00005 00	2
A5CR2	Diode, 1N277, same as A5CR1		ref
A5I1	Integrated Circuit, LM340T-5.0	431 00064 01	1
A5I2	Integrated Circuit, LM377N	431 00058 01	1
A5L1	Coil, rf, 500 μH	701 00017 01	1
A5Q1	Transistor, FET, 2N5484 selected	400 00001 01	1
A5Q2	Transistor, PNP, silicon, 2N3702	400 00012 00	1
A5R1	Res, 1000 ohms ±5%, ¼ W, carbon	500 00102 00	4
A5R2	Res, 56 k ohms ±5%, ¼ W, carbon	500 00563 00	1
A5R3	Res, 1 Meg ohm ±5%, ¼ W, carbon	500 00105 00	3
A5R4	Res, 1000 ohms, same as A5R1		ref
A5R5	Res, 2200 ohms ±5%, ¼ W, carbon	500 00222 00	1
A5R6	Res, 2400 ohms ±5%, ¼ W, carbon	500 00242 00	1
A5R7	Res, 1000 ohms, same as A5R1		ref
A5R8	Res, 1000 ohms, same as A5R1		ref
A5R9	Res, 4700 ohms, ±5%, ¼ W, carbon	500 00472 00	3
A5R10	Res, 4700 ohms, same as A5R9		ref
A5R11	Res, 4700 ohms, same as A5R9		ref
A5R12	Res, 3900 ohms ±5%, ¼ W, carbon	500 00392 00	1
A5R13	Res, 1 Meg ohms, same as A5R3		ref
A5R14	Res, 5600 ohms ±5%, ¼ W, carbon	500 00562 00	1
A5R15	Res, 100 k ohms ±5%, ¼ W, carbon	500 00104 00	1
A5R16	Res, 1 Meg ohm, same as A5R3		ref
A5S1	Switch, rotary, detent only	720 00021 00	1
A5S1	Switch, rotary, wafer only	720 00021 01	1
A5CR1	Diode, Zener, 4.3 V, 1N5229B	410 00035 00	1
A5Y1	Crystal, 2216.500 kHz	765 00004 01	1
A5Y2	Crystal, 2213.500 kHz	765 00003 01	1
	DISPLAY ASSEMBLY A6 **The Display Assembly A6 Consists of A7, A8, A10, and the following:**		
A6DS1	Lamp Assy, Indicator	742 00003 00	2
A6DS2	Lamp Assy, same as A6DS1		ref
	DISPLAY READOUT ASSEMBLY A7		
A7	Circuit Card Assy, Display Readout	110 00097 00	
A7C1	Cap, 22 μF ±20%, 15 wvdc, tantalum	640 00002 00	2
A7C2	Cap 22 μF, same as A7C1		ref
A7I1	Integrated Circuit, 4553	430 00002 00	2
A7I2	Integrated Circuit, 4543	430 00072 00	2
A7I3	Integrated Circuit, MAN3620	430 00003 00	6
A7I4	Integrated Circuit, same as A7I3		ref
A7I5	Integrated Circuit, same as A7I3		ref

PARTS LIST

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
A7I6	Integrated Circuit, same as A7I1		ref
A7I7	Integrated Circuit, same as A7I2		ref
A7I8	Integrated Circuit, same as A7I3		ref
A7I9	Integrated Circuit, same as A7I3		ref
A7I10	Integrated Circuit, same as A7I3		ref
A7J1	Connector, 3-pin W/Carrier Strip	812 00021 03	1
A7J2	Connector, 11-pin W/Carrier Strip	812 00021 11	1
A7Q1	Transistor, silicon, PNP, 2N4403	400 00036 00	5
A7Q2	Transistor, same as A7Q1		ref
A7Q3	Transistor, same as A7Q1		ref
A7Q4	Transistor, same as A7Q1		ref
A7Q5	Transistor, same as A7Q1		ref
A7R1	Res, 2700 ohms, ±5%, ¼ W, carbon	500 00272 00	3
A7R2	Res, 2700 ohms, same as A7R1		ref
A7R3	Res, 2700 ohms, same as A7R1		ref
A7R4	Res, 750 ohms ±5%, ¼ W, carbon	500 00751 00	14
A7R5	Res, 750 ohms, same as A7R4		ref
A7R6	Res, 750 ohms, same as A7R4		ref
A7R7	Res, 750 ohms, same as A7R4		ref
A7R8	Res, 750 ohms, same as A7R4		ref
A7R9	Res, 750 ohms, same as A7R4		ref
A7R10	Res, 750 ohms, same as A7R4		ref
A7R11	Res, 20 k ohms ±5%, ¼ W, carbon	500 00203 00	2
A7R12	Res, 620 ohms ±5%, ¼ W, carbon	500 00621 00	2
A7R13	Res, 20 k ohms, same as A7R11		ref
A7R14	Res, 620 ohms, same as A7R12		ref
A7R15	Res, 750 ohms, same as A7R4		ref
A7R16	Res, 750 ohms, same as A7R4		ref
A7R17	Res, 750 ohms, same as A7R4		ref
A7R18	Res, 750 ohms, same as A7R4		ref
A7R19	Res, 750 ohms, same as A7R4		ref
A7R20	Res, 750 ohms, same as A7R4		ref
A7R21	Res, 750 ohms, same as A7R4		ref
	TIMING AND MIXER ASSEMBLY A8		
A8	Circuit Card Assy, Timing/Mixer	110 00154 01	1
A8C1	Cap, 0.01 μF (+80, -20%) ceramic	600 00003 00	6
A8C2	Cap, 0.01 μF, same as A8C1		
A8C3	Cap, 39 pF ±5%, 100 wvdc, silver mica	610 20039 21	1
A8C4	Cap, var. 2.4-24.5 pF, air dielectric	650 00008 00	1
A8C5	Cap, 0.01 μF, same as A8C1		
A8C6	Cap, 100 pF ±5%, 100 wvdc, sliver mica	610 20100 21	1
A8C7	Cap, 0.01 μF, same as A8C1		
A8C8	Cap, 0.01 μF, same as A8C1		
A8C9	NOT USED		
A8C10	Cap, 110 pF ±5%, 100 wvdc, silver mica	610 20110 21	1
A8C11	Cap, 0.1 μF ±10%, 50 wvdc, mono	600 00015 01	9
A8C12	Cap, 0.01 μF, same as A8C1		
A8C13	Cap, 10 μF ±20%, 15 wvdc, tantalum	640 00001 01	6
A8C14	Cap, 0.1 μF, same as A8C11		
A8C15	Cap, 10 μF, same as A8C13		
A8C16	Cap, 0.1 μF, same as A8C11		
A8C17	Cap, 10 μF, same as A8C13		
A8C18	Cap, 0.1 μF, same as A8C11		
A8C19	Cap, 10 μF, same as A8C13		
A8C20	Cap, 0.1 μF, same as A8C11		
A8C21	Cap, 10 μF, same as A8C13		
A8C22	Cap, 0.1 μF, same as A8C11		
A8C23	Cap, 10 μF, same as A8C13		
A8C24	Cap, 0.1 μF, same as A8C11		

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
A8C25	Cap, 0.0047 μF ±10%, 100 wvdc, polyester	620 00024 00	1
A8C26	Cap, 240 pF ±5%, 100 wvdc, silver mica	610 20240 21	2
A8C27	Cap, 240 pF, same as A8C26		
A8C28	Cap, 0.1 μF, same as A8C11		
A8C29	Cap, 1 μF ±20%, 100 wvdc, mylar	620 00023 00	1
A8C30	Cap, 0.1 μF, same as A8C11		
A8CR1	Diode, silicon, 1N457	410 00031 00	2
A8CR2	Diode, 1N457, same as A8CR1		
A8I1	IC, DIP, type LM311N	431 00055 01	2
A8I2	IC, DIP LM311N, same as A8I1		
A8I3	IC, DIP, type 358	431 00054 00	1
A8I4	IC, DIP, type 4013	430 00048 00	7
A8I5	IC, DIP type CD4013BE	430 00048 02	1
A8I6	IC, DIP 4013, same as A8I4		
A8I7	IC, DIP, type 4025	430 00051 00	2
A8I8	IC, DIP, type 4017	430 00050 00	3
A8I9	IC, DIP, 4017, same as A8I8		
A8I10	IC, DIP, type 4020	430 00060 00	1
A8I11	IC, DIP, 4013, same as A8I4		
A8I12	IC, DIP, type 4023	430 00056 00	1
A8I13	IC, DIP, type 4011	430 00046 00	2
A8I14	IC, DIP, 4013, same as A8I4		
A8I15	IC, DIP, 4025, same as A8I7		
A8I16	IC, DIP, 4013, same as A8I4		
A8I17	IC, DIP, type 74C73	430 00064 00	1
A8I18	IC, DIP, 4013, same as A8I4		
A8I19	IC, DIP, type 4518	430 00009 00	1
A8I20	IC, DIP, type 4516	430 00006 00	1
A8I21	IC, DIP, 4011, same as A8I13		
A8I22	IC, DIP, 4013, same as A8I4		
A8I23	IC, DIP, 4017, same as A8I8		
A8I24	IC, DIP, 74C221	430 00069 00	1
A8I25	IC, Metal Can 3028A	431 00010 00	1
A8L1	Coil, rf 1.5 mH	701 00014 00	2
A8L2	Coil, rf 1.5 mH, same as A8L1		
A8P1	Connector, 3-pin W/Carrier Strip	812 00022 03	1
A8P2	Connector, 11-pin W/Carrier Strip	812 00022 11	1
A8Q1	NOT USED		
A8Q2	Transistor, PNP, PN5910	400 00039 00	1
A8Q3	NOT USED		
A8Q4	NOT USED		
A8Q5	Transistor, NPN, 2N3704	400 00013 00	2
A8Q6	Transistor, 2N3704, same as A8Q5		
A8Q7	Transistor, PNP, 2N5087	400 00021 00	2
A8Q8	Transistor, 2N5087, same as A8Q7		
A8R1	Res, 20 k ohms ±5%, ¼ W, carbon	500 00203 00	4
A8R2	Res, 10 k ohms ±5%, ¼ W, carbon	500 00103 00	7
A8R3	Res, 1000 ohms ±5%, ¼ W, carbon	500 00102 00	2
A8R4	Res, 10 k ohms, same as A8R2		
A8R5	Res, 20 k ohms, same as A8R1		
A8R6	Res, 2000 ohms ±5%, ¼ W, carbon	500 00202 00	2
A8R7	Res, 24 k ohms ±5%, ¼ W, carbon	500 00243 00	1
A8R8	Res, 10 k ohms, same as A8R2		
A8R9	Res, 10 k ohms, same as A8R2		
A8R10	Res, 1000 ohms, same as A8R3		
A8R11	Res, 100 k ohms ±5%, ¼ W, carbon	500 00104 00	5
A8R12	Res, 10 k ohms, same as A8R2		
A8R13	Res, 100 k ohms, same as A8R11		
A8R14	Res, 10 k ohms, same as A8R2		

PARTS LIST

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
A8R15	Res, 2000 ohms, same as A8R6		
A8R16	Res, 200 k ohms, ±5%, ¼ W, carbon	500 00204 00	1
A8R17	Res, var. 500 ohms ±10%, ½ W, cermet	542 00003 00	1
A8R18	Res, 1 Meg ohm ±5%, ¼ W, carbon	500 00105 00	2
A8R19	Res, 1 Meg ohm, same as A8R18		
A8R20	Res, 47 k ohms ±5%, ¼ W, carbon	500 00473 00	1
A8R21	Res, 750 ohms ±5%, ¼ W, carbon	500 00751 00	2
A8R22	Res, 3600 ohms ±5%, ¼ W, carbon	500 00362 00	1
A8R23	Res, 10 k ohms, same as A8R2		
A8R24	Res, 750 ohms, same as A8R21		
A8R25	Res, 2.2 Meg ohms ±5%, ¼ W, carbon	500 00225 00	2
A8R26	Res, 2.2 Meg ohms, same as A8R25		
A8R27	Res, 100 k ohms, same as A8R11		
A8R28	Res, 20 k ohms, same as A8R1		
A8R29	Res, 100 k ohms, same as A8R11		
A8R30	Res, 20 k ohms, same as A8R1		
A8R31	Res, 100 k ohms, same as A8R11		
A8Y1	Crystal, Quartz, 2205.000 kHz	765 00005 00	1
	CHARGING CONTROL ASSEMBLY A9		
A9	Circuit Card Assembly, Charging Control	110 00098 00	
A9C1	Cap, 0.01 μF (+80%, -20%), 25 wvdc, disc	600 00003 00	1
A9CR1	Diode, 3-junction stabister, STB 568	410 00006 00	1
A9CR2	Rectifier, silicon, CB80	410 00023 00	1
A9CR3	Diode, silicon, 1N914	410 00014 00	1
A9I1	Integrated Circuit, 8V reg. LM340T-8	431 00065 00	1
A9Q1	Transistor, NPN, 2N3704	400 00013 00	1
A9Q2	Transistor, PNP, 2N3702	400 00012 00	1
A9R1	Res, 100 ohms ±5%, ½ W, carbon	502 00101 00	1
A9R2	Res, 4 ohms ±5%, 3.0-3.75 W, wire wound	560 00001 04	1
A9R3	Res, var, 200 ohms ±20%, cermet	542 00008 06	1
A9R4	Res, 210 ohms ±5%, ¼ W, 70° C, film	561 00004 04	1
A9R5	Res, 294 ohms ±1%, ⅛ W, 70° C, film	511 22940 00	1
A9R6	Res, 340 ohms ±2%, ½ W, 70° C, film	561 00003 02	1
A9R7	Res, 2400 ohms ±5%, ¼ W, carbon	500 00242 00	1
A9R8	Res, 15 k ohms ±5%, ¼ W, carbon	500 00153 00	1
A9R9	Res, 1 k ohms ±5%, ¼ W, carbon	500 00102 00	1
A9RT1	Thermistor, 100 ohms	440 00001 00	1
	COUNTER OUTPUT ASSEMBLY A10		
A10	Circuit Card Assy, Counter Output	110 00117 00	
A10C1	Cap, 22 μF ±20%, 16 wvdc, tantalum	640 00001 05	1
A10C2	Cap, 0.1 μF ±10%, 50 wvdc, mono	600 00015 01	1
A10I1	Integrated Circuit, 4030B	430 00052 10	1
A10I2	Integrated Circuit, 4013B	430 00048 10	1
A10L1	Parasitic suppressor	701 00044 00	1
A10R1	Res, 100 ohms ±5%, ¼ W, carbon	500 00101 00	1
A10R2	Res, 4700 ohms ±5%, ¼ W, carbon	500 00472 00	1
A10R3	Res, 390 ohms ±5%, ¼ W, carbon	500 00391 00	1
	CAL-OSC ASSEMBLY A11		
A11	Circuit Card Assy, Cal-Osc	110 00089 01	
A11C1	Cap, 15 pF ±5%, 100 wvdc, silver mica	610 20015 21	1
A11C2	Cap, 650 pF ±5%, 100 wvdc, silver mica	611 20650 21	1
A11C3	Cap, 0.1 μF ±10%, 50 wvdc, mono	600 00015 01	3
A11C4	Cap, 0.1 μF, same as A11C3		ref
A11C5	Cap, 0.1 μF, same as A11C3		ref

PARTS LIST

REF DES	DESCRIPTION	RYCOM NO.	QTY/ ASSY
A11I1	Integrated Circuit, type 4001	430 00058 00	1
A11I2	Integrated Circuit, type MC78L05CP	431 00009 04	1
A11R1	Res, 4700 ohms ±5%, ¼ W, carbon	500 00472 00	1
A11R2	Res, 1 Meg ohms ±5%, ¼ W, carbon	500 00105 00	1
A11R3	Res, 7500 ohms ±5%, ¼ W, carbon	500 00752 00	1
A11R4	Res, 68.1 k ohms ±5%, ¼ W, 70° C, film	561 00004 02	1
A11R5	Res, var, 20 ohms ±20%, ½ W, cermet	542 00003 08	1
A11R6	Res 20 ohms ±5%, ¼ W, 70° C, film	561 00004 03	1
A11Y1	Crystal, Quartz, 250.00 kHz	765 00011 00	1

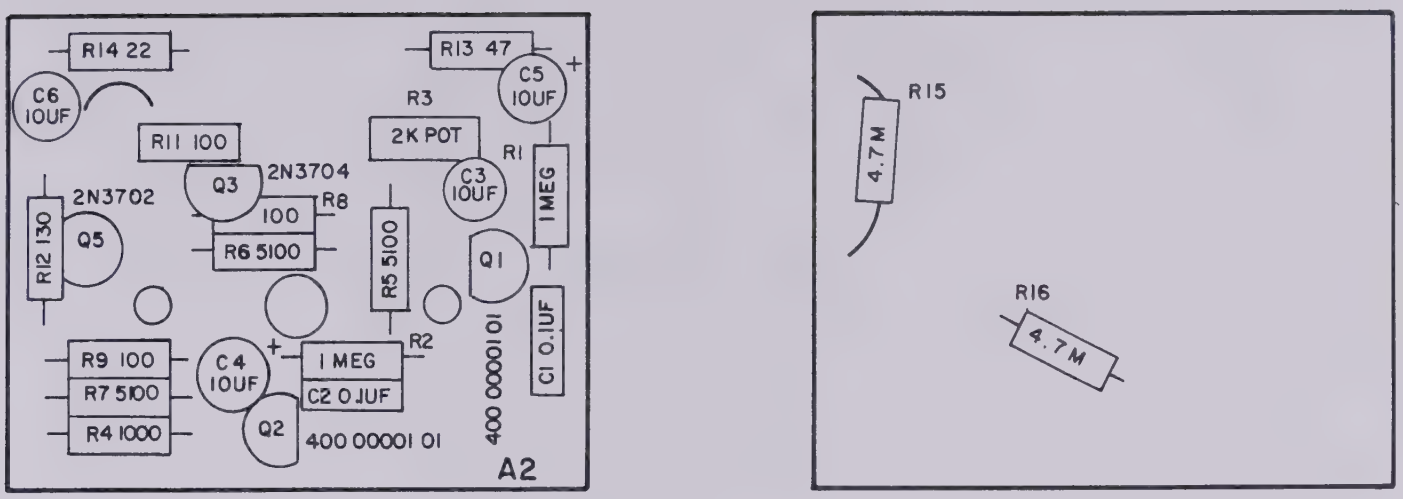

Figure 5. Summing Amplifier Assembly A2

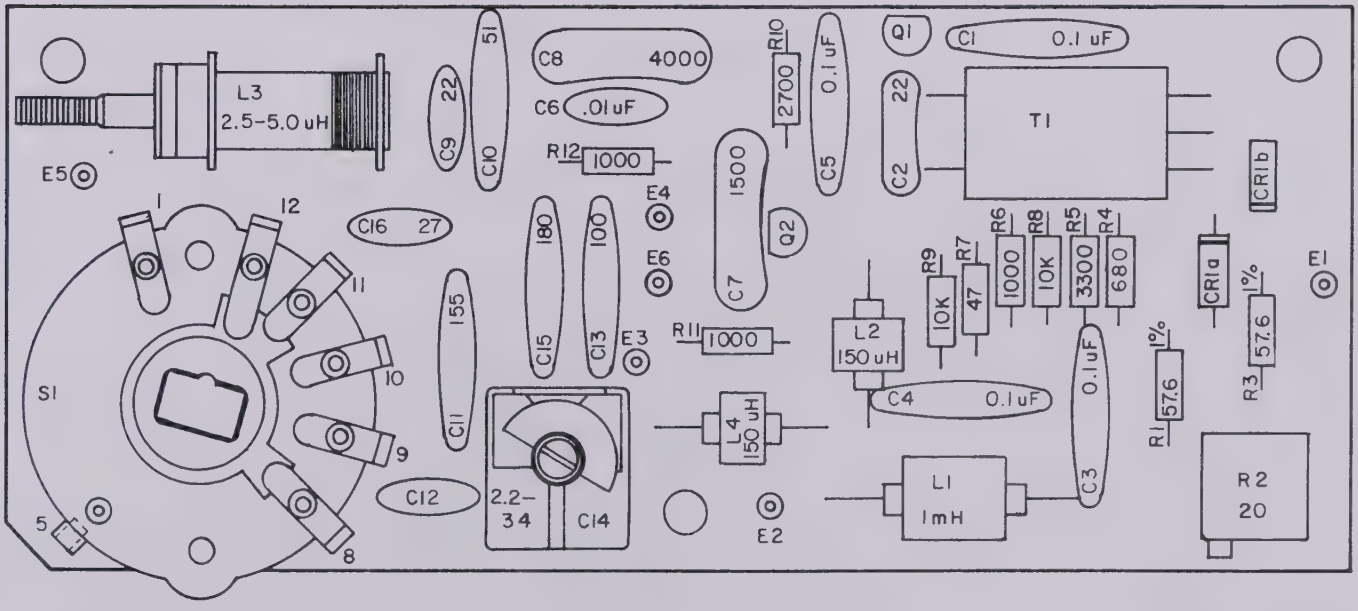

Figure 6. Local Oscillator Assembly A3

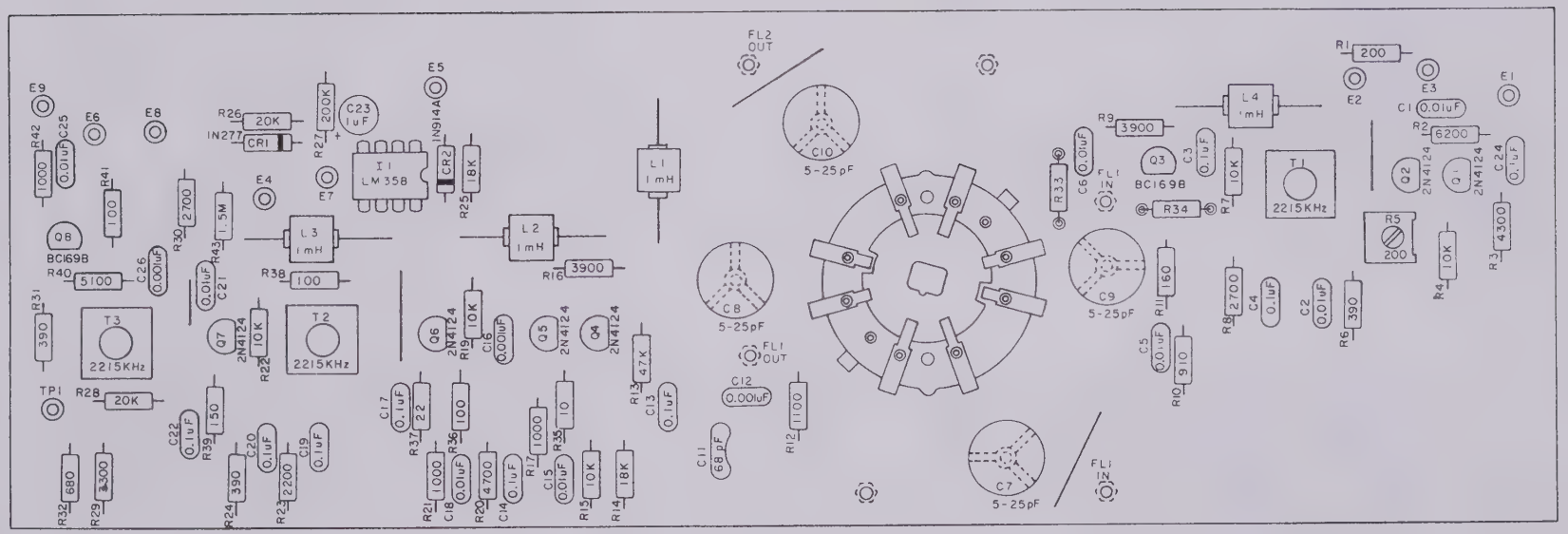

Figure 7. I-F Assembly A4

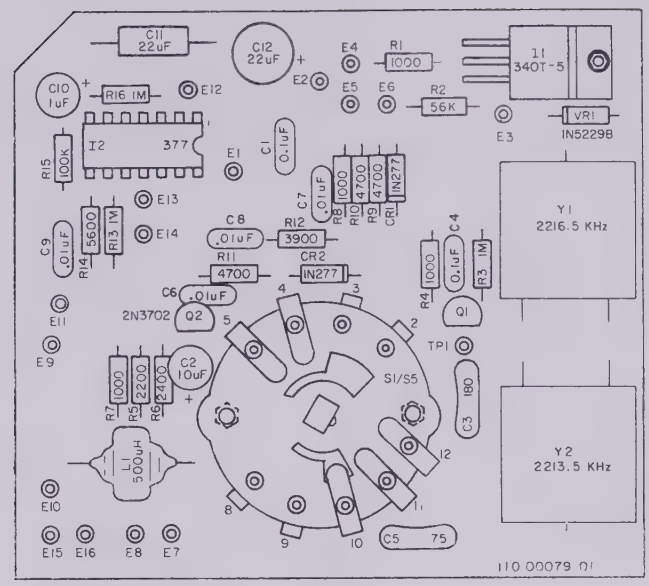

Figure 8. Monitor Assembly A5

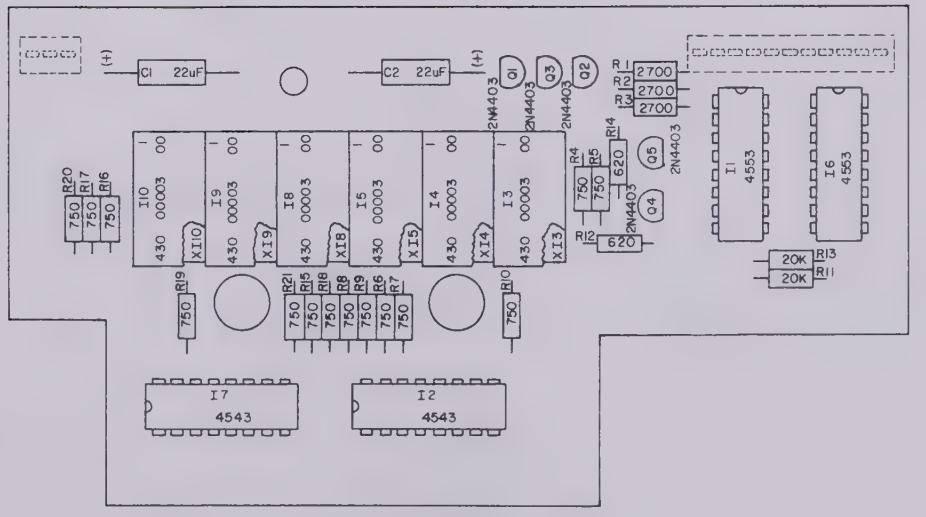

Figure 9. Display Readout Assembly A7

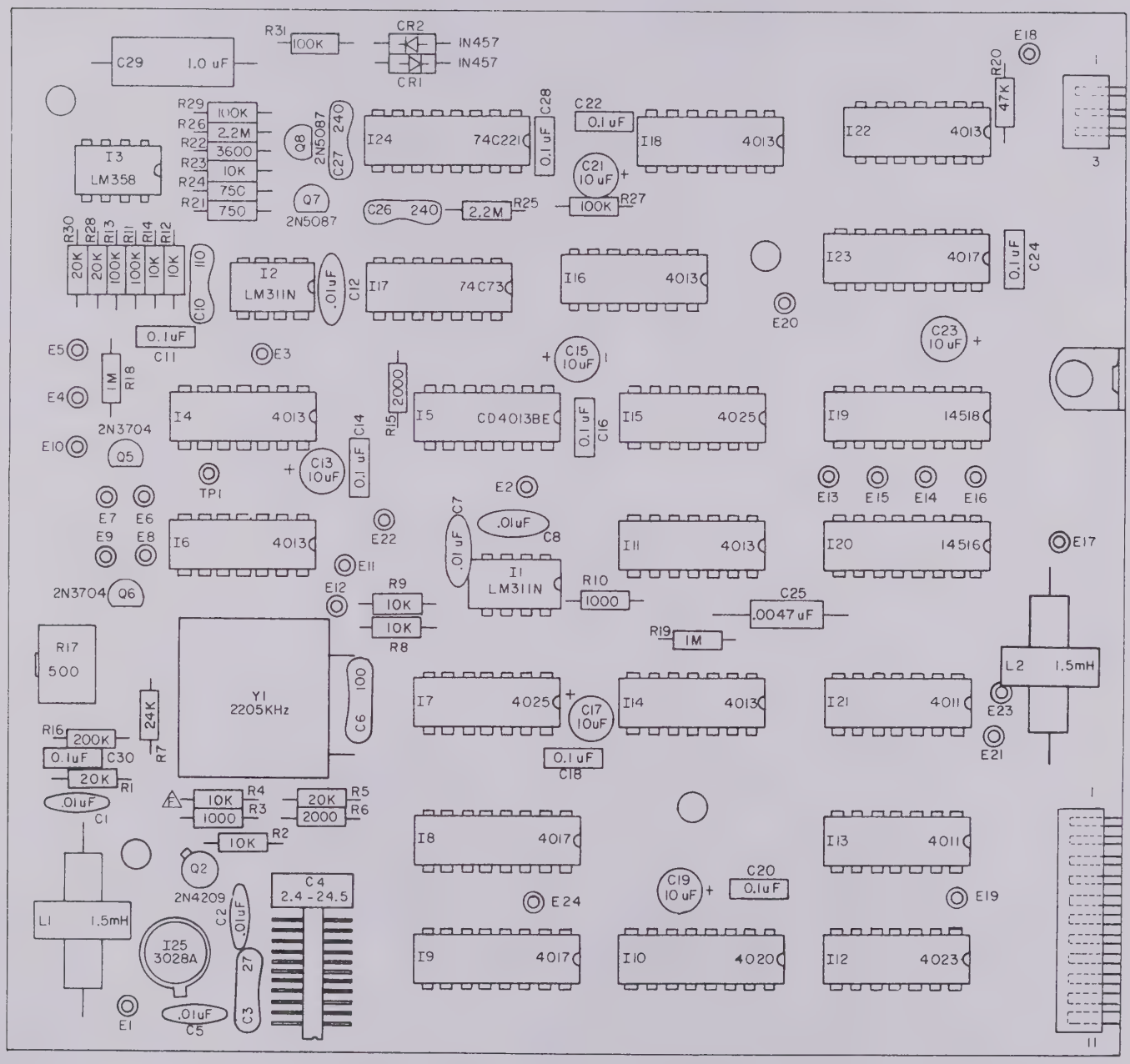

Figure 10. Timing and Mixer Assembly A8

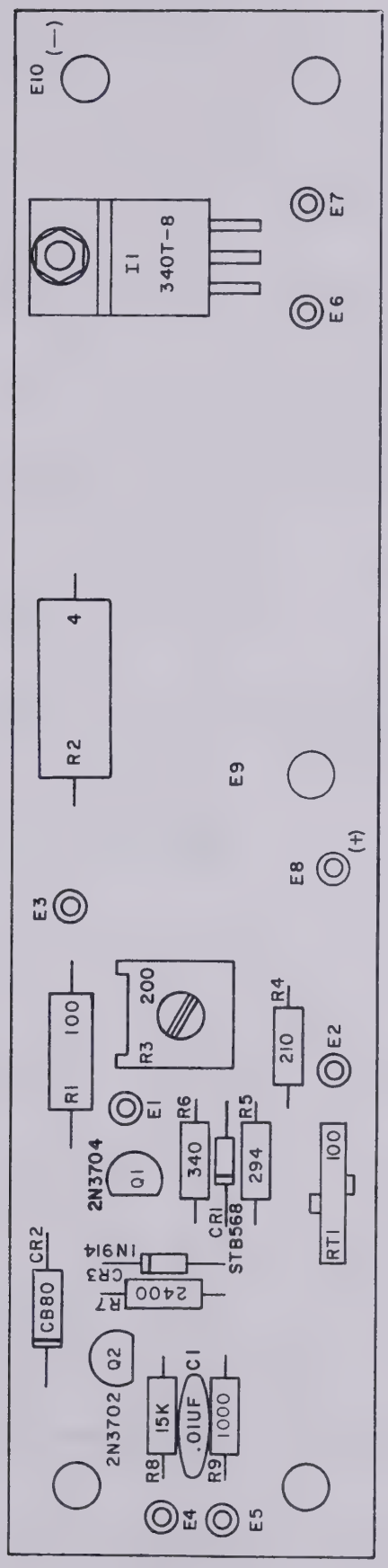

Figure 11. Charging Control Assembly A9

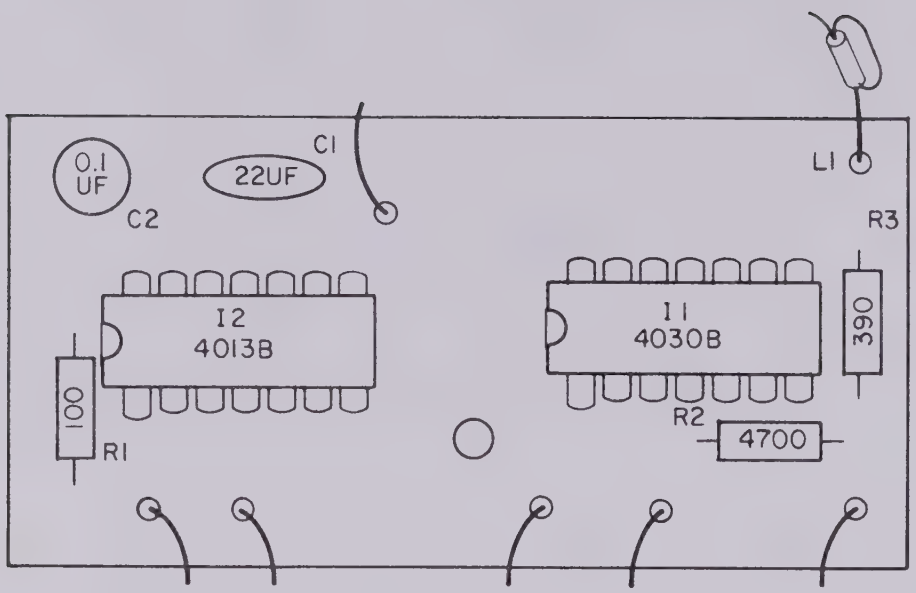

Figure 12. Counter Output Assembly A10

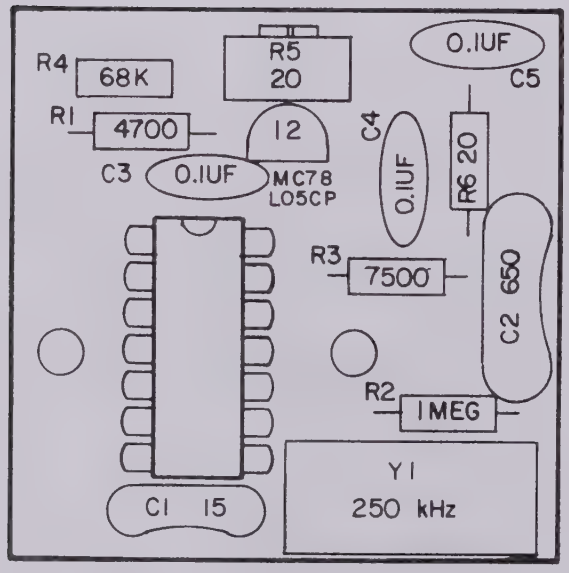

Figure 13. Cal-Osc Assembly A11

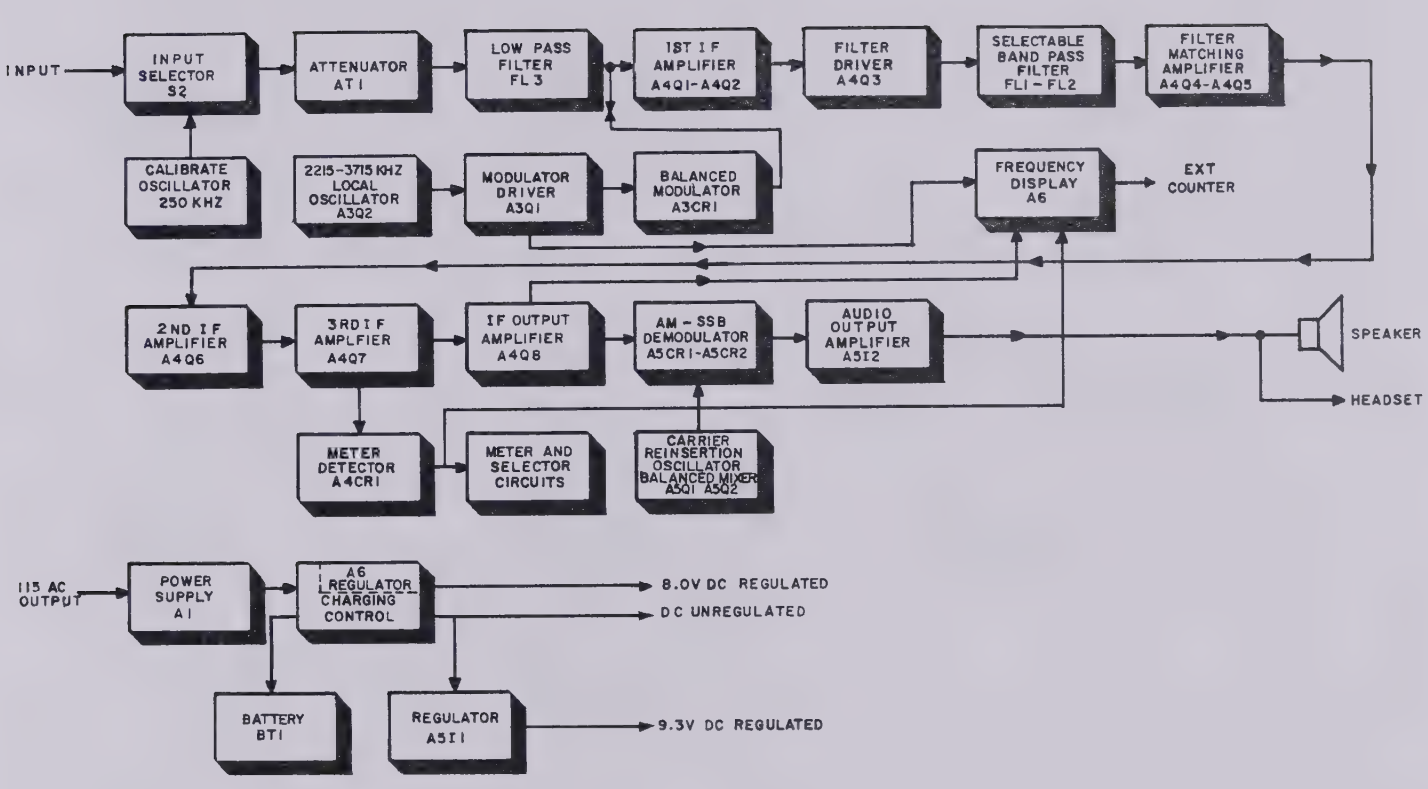

Figure 14: Selective Levelmeter Block Diagram

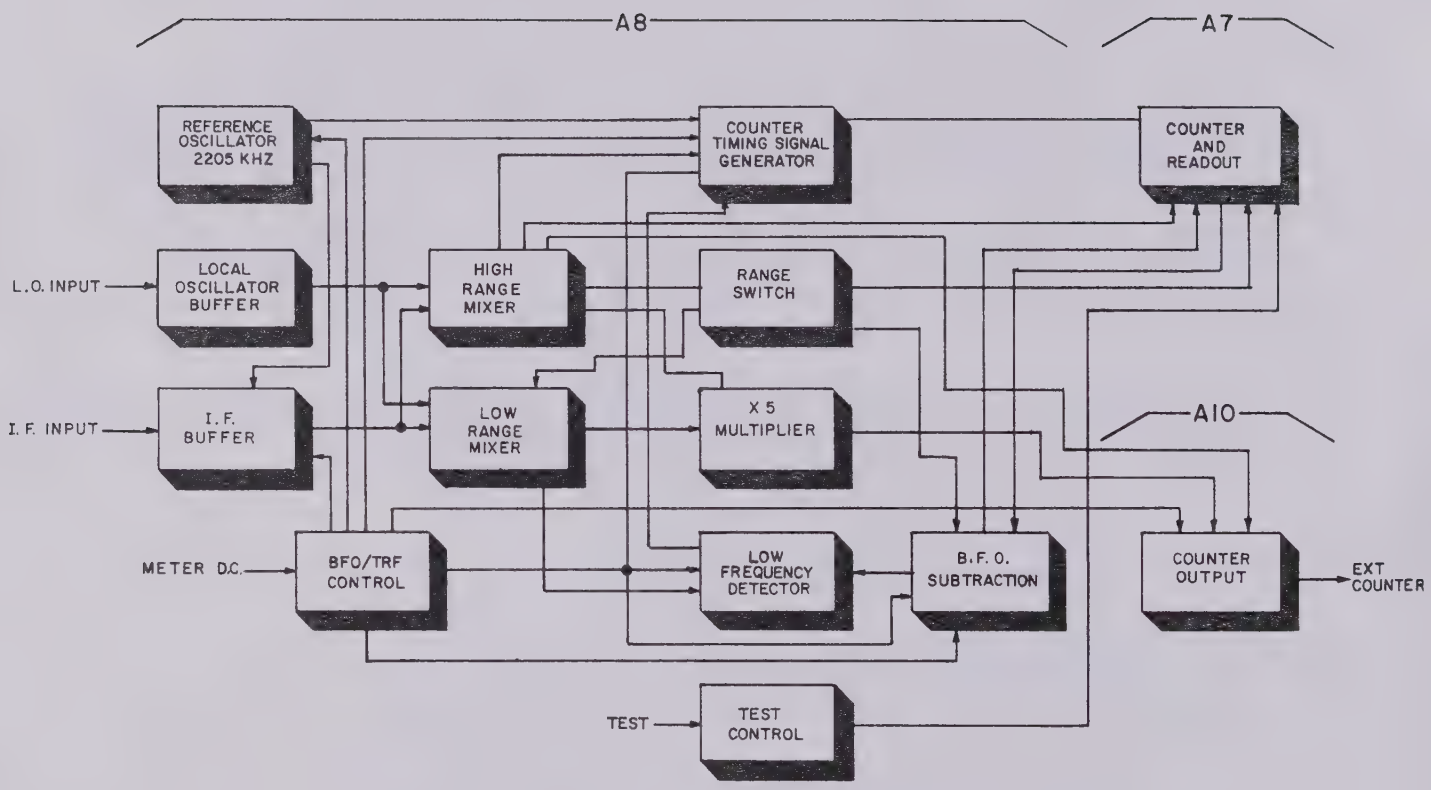

Figure 15: Frequency Display Diagram

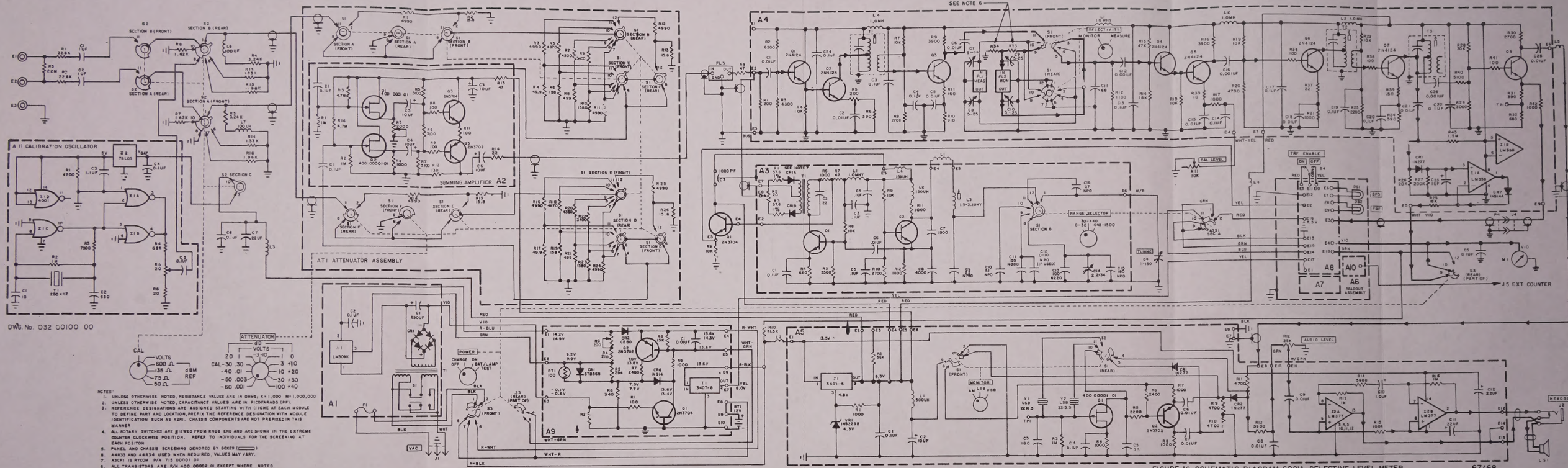
A11 CALIBRATION OSCILLATOR
DWG. No. 032 00100 00
A1 ATTENUATOR ASSEMBLY
SUMMING AMPLIFIER A2
A4
A3
A5
A9
A8
A10
A6
A7
SEE NOTE 6
J5 EXT COUNTER
HEADSET
ATTENUATOR
CAL
VOLTS
dB
dBM
REF
NOTES:
1. UNLESS OTHERWISE NOTED, RESISTANCE VALUES ARE IN OHMS, K=1,000 M=1,000,000
2. UNLESS OTHERWISE NOTED, CAPACITANCE VALUES ARE IN MICROFARADS (MF).
3. REFERENCE DESIGNATIONS ARE ASSIGNED STARTING WITH (1)ONE AT EACH MODULE TO DEFINE PART AND LOCATION, PREFIX THE REFERENCE DESIGNATION WITH MODULE IDENTIFICATION SUCH AS A2R1. CHASSIS COMPONENTS ARE NOT PREFIXED IN THIS MANNER
4. ALL ROTARY SWITCHES ARE VIEWED FROM KNOB END AND ARE SHOWN IN THE EXTREME COUNTER CLOCKWISE POSITION. REFER TO INDIVIDUALS FOR THE SCREENING AT EACH POSITON
5. PANEL AND CHASSIS SCREENING DENOTED BY BOXES ( )
6. A4R33 AND A4R34 USED WHEN REQUIRED, VALUES MAY VARY.
7. A3CR1 IS RYCOM P/N 715 00001 01
8. ALL TRANSISTORS ARE P/N 400 00002 01 EXCEPT WHERE NOTED

FIGURE 16 SCHEMATIC DIAGRAM 6021A SELECTIVE LEVEL METER 67/68

Figure 16. 6021A Selective Levelmeter Schematic Diagram

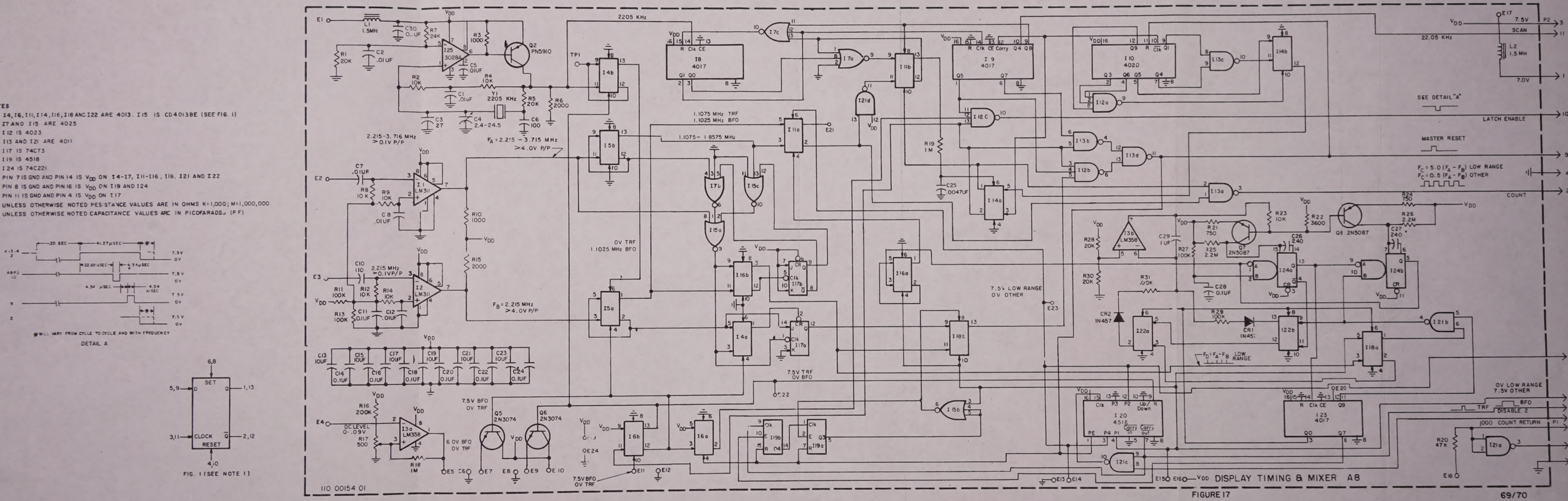
NOTES
1 I4, I6, I11, I14, I16, I18 AND I22 ARE 4013. I15 IS CD40138E (SEE FIG. 1)
2 I7 AND I15 ARE 4025
3 I12 IS 4023
4 I13 AND I21 ARE 4011
5 I17 IS 74C73
6 I19 IS 4518
7 I24 IS 74C221
8 PIN 7 IS GND AND PIN 14 IS VDD ON I4-17, I11-I16, I18, I21 AND I22
9 PIN 8 IS GND AND PIN 16 IS VDD ON I19 AND I24
10 PIN 11 IS GND AND PIN 4 IS VDD ON I17
11 UNLESS OTHERWISE NOTED RESISTANCE VALUES ARE IN OHMS K=1,000; M=1,000,000
12 UNLESS OTHERWISE NOTED CAPACITANCE VALUES ARE IN PICOFARADS (P F)
DETAIL A
* WILL VARY FROM CYCLE TO CYCLE AND WITH FREQUENCY
FIG. 1 (SEE NOTE 1)
2205 KHz
1.1075 MHz TRF
1.1025 MHz BFO
1.1075- 1.8575 MHz
2.215-3.716 MHz
>0.1V P/P
FA = 2.215 - 3.715 MHz
>4.0V P/P
0V TRF
1.1025 MHz BFO
2.215 MHz
>0.1VP/P
FB = 2.215 MHz
>4.0V P/P
7.5V TRF
0V BFO
7.5V BFO
0V TRF
6.0V BFO
0V TRF
7.5V LOW RANGE
0V OTHER
FD = FA - FB LOW RANGE
0V LOW RANGE
7.5V OTHER
22.05 KHz
SEE DETAIL "A"
LATCH ENABLE
MASTER RESET
FC = 5.0 (FA - FB) LOW RANGE
FC = 0.5 (FA - FB) OTHER
COUNT
1000 COUNT RETURN
DISPLAY TIMING & MIXER A8
110 00154 01
FIGURE 17
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Figure 17. Timing and Mixer Schematic Diagram